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REPORT OF THE COMMISSION ON ELECTRIC LIGHTING FOR THE CITY OF NEW YORK.

The second report of the Commission on Electric Lighting for the City of New York has been submitted to Mayor George B. McClellan. The commission consists of Dr. Cary T. Hutchinson, Mr. Nelson P. Lewis and Mr. George F. Sever, well-known engineers of New York. This report gives in detail estimates of the cost for a municipal plant large enough to light all the streets of the boroughs of Manhattan and The Bronx, and all of the public buildings. The report also contains specifications for the complete installation of this plant, which is planned for a maximum output of 20,000 kilowatts. Abstracts of this report will be published in an early issue of the ELECTRICAL REVIEW.

At the present time there are 290 miles of streets in Manhattan and The Bronx lighted electrically, and there are 442 miles lighted by means of gas or naphtha. It is proposed in this report that all of these 732 miles be lighted electrically by means of arc lamps, Nernst lamps run in series, and incandescent lamps. To do this would require about 15,000 arc lights, an increase of 9,000 over the present number, and about 300,000 incandescent lamps, the latter figure including those required for the public buildings. The generating equipment required for these lights must have an output of 15,000 kilowatts. The total cost of the plant is estimated at $7,567,000, of which $533,000 is allowed for the real estate upon which the central station and substations are to be erected. Apportioning the cost of the station to the arc and incandescent services, it is found that the investment will be $352 per arc lamp and $153 per kilowatt of connected load of incandescent lamps.

It is estimated that the total operating expenses will be $1,269,000 per year. This allows for three and one-half per cent interest on the investment, and six per cent depreciation. Subdividing this sum into the cost of supplying arc and incandescent lamps, the annual cost per arc lamp is found to be $64.07, and the cost per kilowatt-hour for the incandescent service, five and one-half cents. The report states that the total cost to the city of gas and electric lights for last year was $1,703,000, leaving an estimated saving for operating the plant proposed over the present cost of lighting the streets of $434,000. The general plan proposed in the report is the generation of alternating three-phase current, at sixty cycles, 11,000 volts, and distributing this by means of cables run underground in ducts in Manhattan and by overhead lines in The Bronx to substations, where the transformers will be located. At the substations the pressure will be changed from 11,000 to 2,200 volts, and at the latter pressure it will be transmitted to local centres of distribution, where it will be reduced to 230 volts for single-phase, three-wire distribution. The power-station equipment contemplated will be of the latest and most approved type. There will be water-tube boilers, steam turbines and all the necessary accessories for economical operation of the plant. It is estimated that the cost of generating the electric energy delivered to the lamps will be 1.384 cents per kilowatt-hour.

The estimate does not include any items for laying ducts or erecting poles, since the city has the privilege of carrying its cables through the present system of ducts and over the poles now standing in the borough of The Bronx.

From this report it is apparent that the contemplated undertaking is a large one requiring the most careful consideration. It calls for the expenditure of a large sum of money, and will require the city's adding a new burden on its already well-loaded officials. Municipal undertakings of this kind can not be considered in the same light as would private undertakings of a like magnitude, for one can never feel entirely sure of a continuity of policy, and this feature, as well as the political complications which will inevitably arise, must always be kept in mind. But these are factors which can not be allowed for in a strictly engineering report.

THE METALLIZED CARBON FILAMENT.

An interesting and significant paper presented at the recent convention of the American Institute of Electrical Engineers at Asheville was that by Mr. John W. Howell. It dealt with a new type of carbon filament. This paper is published on another page of this issue, and a perusal of it brings out a number of exceedingly striking points.

These carbon filaments are made from the same material as the ordinary filament. They are also baked and treated in the same way, but they undergo an additional process known as firing. It is this last process which produces such surprising results. The common carbon filament, as is well known, is baked first in an oven so as to carbonize the cellulose. The filament thus prepared forms a base upon which later a coating of graphite is deposited in the flashing process. The additional step through which the metallized filaments are carried consists in heating filaments prepared and treated in the ordinary way to an exceedingly high temperature—a temperature so high that it can not be obtained satisfactorily by passing a current through the filament itself, but must be obtained by passing the filament through an electrically heated furnace. The effect of this treatment seems to be to bring about a metamorphosis of the graphite coating, the process taking but a few moments. The effect of this excessive heat on the carbon base of the filament is slight, but since it appears to cause a certain amount of gas to be given off, which blisters the graphite coating, it has been found preferable to fire the carbon base before it is treated.

The furnace which has been used for this work consists of a hollow carbon rod heated electrically, the filaments, packed in graphite, being passed through this rod. This does not seem to be an expensive process, nor should it be particularly difficult, although, no doubt, a certain amount of skill is required in obtaining satisfactory results, but if the filaments come up to the hopes expressed for them by Mr. Howell, the additional steps required in their manufacture will be but a slight objection. While it is true that a filament which must be baked, fired, flashed and then refired must necessarily be handled more than is now the case with the common carbon filament, this is a matter of small consequence compared with the greatly improved quality of the lamp which results.

The effect of this process of firing the filament is to increase the density of the graphite coating, making it tougher and elastic, so that it resembles in these respects a metal; and, most surprising of all, the resistance of the fired filament increases with temperature, while that of the common carbon decreases. In other words, the process converts the temperature coefficient of resistance from negative to positive, making the filaments in this respect as well to resemble a metal. It is for these reasons that the filament has been called "metallized." Practically all of this change takes place in the graphite shell. There is but little change in the characteristics of the carbon base. This change in the characteristics of graphite could possibly be made use of for other apparatus. It would seem probable that by properly regulating the temperature of the furnace a quality of graphite might be produced in which the resistance will remain practically constant, independent of the temperature, throughout a considerable range. This change in the characteristic of the graphite will affect the characteristics of the lamp in several ways. It will give it better inherent regulation for voltage variations, but will cause a rush of current the moment the lamp is turned on, though this rush may be of insignificant proportions.

The most important result of this treatment of the carbon filament is, of course, the increased efficiency at which it is claimed the lamps may be operated. It is stated in the paper that lamps may now be run satisfactorily at an efficiency of two and one-half watts per candle, and that there is every prospect of doing better than this. The recent report of Dr. Louis Bell to the National Electric Light Association states that tantalum lamps tested would, if rated at 1,000 hours, show an energy consumption of 2.15 watts per mean horizontal candle. This is somewhat better than the efficiency claimed for the new carbon lamp; but, on the other hand, it must be remembered that the carbon lamp will undoubtedly be cheaper than any metallic filament lamp, and will probably be easier to produce uniform. Mr. Howell states that the new lamp has a useful life of 500 hours, about the same as that of the 3.1-watt carbon lamp. On a basis of 2.5 watts per candle for the new lamp and with the price for energy at ten cents per kilowatt-hour, the metallized lamp should be worth about forty-eight cents more than the 3.1-watt lamp, a large figure when the cost of the latter lamp is considered.

EXPLORING THE ATMOSPHERE.

In a contribution to *Nature* (London), for May 25, Mr. G. C. Simpson describes the results of recent explorations of the atmosphere in order to determine its electrical condition. This work has been done by means of kites, but the most valuable results have been obtained from manned balloons. Naturally, the work was not all plain sailing, for unexpected difficulties were encountered. New methods of measuring the electrical condition of the atmosphere were found necessary, and the work was not entirely without risk. The investigations so far made seem to justify the following conclusions: the potential gradient of the atmosphere remains positive to the highest point as yet investigated, which is about 18,000 feet. From this it is believed that the positive charge of the atmosphere balances the negative charge of the earth, so that the globe as a whole is neutral. Another interesting deduction is that the number of charged particles of air—or ions, as they are called—is the same per cubic metre at all heights. However, as there is less interference with the movement of charged particles in the rarer atmosphere, the charge from an electrified body is dissipated more rapidly the higher up it is carried.

This field of exploration should appeal to certain individuals of means and leisure, who have devoted their energies to aerial navigation. The task of investigating the meteorological conditions of the air is not always easy. It is difficult enough to add interest to the work, and the danger is at least sufficient to add

spice. There will be, besides, the knowledge that valuable results may be accomplished, instead of efforts wasted on a problem which, to many, seems foolish. It is not impossible that aerial navigation may be accomplished, but it seems most improbable that it will be brought about by a dirigible balloon. On the other hand, balloons offer, at the present time, the best available method of studying the physics of the upper air.

GAS VERSUS ELECTRICITY FOR DISTRIBUTED STREET LIGHTING.

Quality and prices aside, gas and electricity compete on more nearly equal terms in distributed street lighting than in most other lines of service. By distributed street lighting is meant that which must be done with a comparatively large number of rather low-candle-power lamps, as where only a small sum can be expended per mile of street, or where shade trees are so thick that good results can be obtained only with lamps close together. These conditions make the use of arc lamps impracticable, and the comparison comes between gas and electric incandescent lamps.

The incandescent gas-mantle has raised gas street lamps to a position of importance that the open bat's-wing flame long since lost. This return of prestige to the gas lamps is due to the fact that the incandescent burner increases its illuminating power to as much as five times that of an open flame. For the bat's-wing burner a fair result may be taken as fifteen candle-power with a consumption of five cubic feet of gas per hour, or three candle-power-hours per cubic foot. In the incandescent burner under good conditions it is practicable to get as much as fifteen candle-power-hours per cubic foot of gas consumed per hour.

In street lighting, unlike interior illumination, the heating effects, vitiation of the air, and the fire risk of gas lamps do not weigh heavily against them, and the main factors to be considered are location, candle-power and costs. Gas lamps, as ordinarily erected for street lighting, are at a serious disadvantage as compared with incandescent electric lamps of equal candle-power. This disadvantage is due to the fact that the gas lamp is too near the ground; its lantern, holder and post cast a large shadow, and it lacks an effective reflector above it. In contrast with all this, the incandescent electric lamp may easily be, and usually is, at a suitable height above the ground, has a wide reflector above it, and there are no opaque parts at the side of or below the incandescent filament to cast shadows. Another disadvantage of the gas compared with the electric street lamp, as ordinarily erected, where there is a row of trees on either side of the street, is that the gas lamp, being mounted at the top of a straight post between the trees, throws gigantic shadows to long distances up and down the roadway. The electric lamp, being held out beyond the trees by a long goose-neck, throws its light to a good distance up and down the roadway, where it is most needed. If gas companies can supply an inverted burner, and mount it at the end of a long goose-neck, they will materially increase their power of competition in distributed street lighting.

Most important among the factors that determine the selection of gas or electric incandescent street lamps is the cost per candle-power of each. This conclusion is borne out by the fact that gas street lamps are largely used in cities of the first and second class, where gas is cheap, while in small cities and towns, where gas is much higher, incandescent electric street lamps are much more generally used. For street lighting, incandescent electric lamps rated at twenty-five candle-power and consuming about seventy-five watts are very commonly employed. With equally good location and mounting for each lamp, which is contrary to the facts as above noted, about two cubic feet of good gas per hour in the gas lamp will give an illuminating effect equal to that of the seventy-five-watt incandescent lamp. If the gas sells at one dollar per thousand cubic feet, the operation of this gas lamp costs 0.2 cent per hour. To equal this cost of operation, energy for the seventy-five-watt incandescent lamp must be sold at 2.66 cents per kilowatt-hour. Where the price of gas is two dollars per thousand feet, as in many small places, the equivalent price of electric energy may be raised to 5.32 cents per kilowatt-hour, and a large amount of incandescent electric street lighting is done at not more than this figure.

THE TEMPERATURE OF THE NEW YORK SUBWAY.

Since the beginning of the hot weather there has been considerable complaint made about the temperature of the air in the New York subway. Patrons of the subway have been surprised to find the air there several degrees warmer than the air on the streets. They had expected that it would be cooler, comparing the subway with other underground rooms. That the air should be warmer is only to be expected when one remembers the amount of work that is being done continuously there, and that all of the energy which it represents is being converted eventually into heat. Taking up this phase of the problem, the *Engineering News,* in its issue of June 15, says that the energy required to operate and light the subway amounts to about 380 kilowatt-hours per day of twenty-four hours. This is equivalent to 1,292,000,000 heat units. The air enclosed in the subway weighs practically 3,000,000 pounds, and as the specific heat of air is practically 0.25, the energy expended there daily is sufficient to heat the whole of the subway air two hundred times a day to a temperature six degrees higher than the outside temperature. This is allowing for the loss of heat by conduction through the roof and sides of the subway. If, therefore, the temperature of the subway is to be maintained at not more than six degrees above that of the outside air, it must be changed about once every seven minutes. This shows that this tremendous ventilating problem is one rather of cooling than of supplying pure air. No doubt the air in the subway is changed much more frequently than any one would at first assume. Its oppressive character is due rather to its great humidity and higher temperature, as well as to its stillness when compared with the air above the ground.

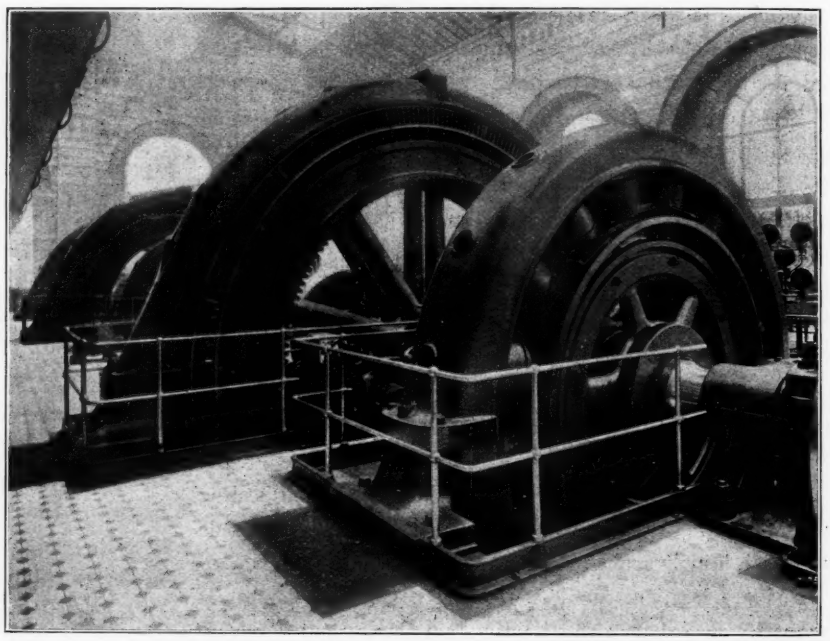
The Power Plant at Harland & Wolff's Shipbuilding Works.

THE large shipbuilding works of Harland & Wolff at Belfast, Ireland, have recently been converted from mechanical to electric driving. The new equipment is probably the largest and most complete of its kind at present in the United Kingdom. The works are situated on the river Lagan, and cover a large section of ground. However, on account of the large number of buildings and building slips already in existence, the land available for the power-house was somewhat restricted, and the shape was not as desirable as could be wished. Although a supply of electric power was available from the local electric power plant, the latter was some distance from the yards, and as the power required by the works is large, it was deemed advisable for the company to erect and equip its own plant. This has now been done, the work being entrusted to Mr. J. W. Kempster, head of the electrical department of Harland & Wolff, who designed and superintended the entire electrical installation, including the shop equipment and the power-house as well, and to whom credit must be given for the excellence of the plans and the way in which they have been carried out.

The requirements of shipyard operation seemed to make desirable several classes of electrical supply. Realizing that in this work the labor item is far more important than the cost of power, the plant has been designed so as to enable the men to work most efficiently, and the electrical equipment for each and every tool has been selected so as to allow that machine to be operated so as to give the highest output. An increase of ten or twenty per cent in the output of the men or machines more than balances the increased cost of the power or of the electrical equipment necessary to obtain it. For this reason there are three classes of power supply to the works: a three-phase, 440-volt, sixty-cycle, alternating-current system; a 450-volt, direct-current system, which, by means of the three-wire system, makes available 225 volts; and a 110-volt, direct-current system. As far as possible each machine has been equipped with an individual motor selected to fit its requirements, the greater number of these being three-phase induction motors, which were chosen because it was thought that the repairs on these motors would be considerably less than with direct-current motors. Where the characteristics of this motor are less suitable than those of direct-current motors, the latter have been installed, such, for example, as in hoisting work and operating cranes.

The power-house is a narrow building about sixty-eight feet wide and 469 feet long. It contains not only the generating room and the boiler house, but the electrical fitting and repair shops and the storerooms, the latter being placed at one end of the building. As this building was erected on newly made ground, piling was necessary to support the walls, engine and generator foundations. The walls of the building are carried on a thousand larch piles about forty feet long, on which are placed timber rafts made up of wooden beams ten by nine inches. The foundations are of concrete, and are laid on and around these timber rafts. The engine and generator foundations, as well as that of the chimney, are carried on 500 pine piles twelve inches square and forty feet in length. On the piles placed under the engine foundations channel irons eleven by three inches are placed, and are so arranged as to distribute the weight evenly over the whole system of piles.

The boiler room contains five marine boilers of the single-ended type. These were constructed at the Harland & Wolff works. Each has a heating surface of 2,225 square feet. The area of the grate surface is fifty-six and three-quarters square feet. The boilers are ten feet six inches long, and fourteen feet eight inches in diameter. They are arranged so that the hot gases are carried around and under the boilers before passing through the flues. The pressure at which steam is generated is 200 pounds per square inch. It is carried from the boiler room to the engine room in a ten-inch, wrought-iron main arranged in a ring. The sections of this pipe are coupled together with wrought-steel pressed flanges. The ring arrangement of steam main gives a duplicate steam supply, though but one side will be in use normally. The necessary expansion joints have been installed. Space has been reserved in the boiler room for five more boilers of the same type and size.



DIRECT-CURRENT AND THREE-PHASE ALTERNATING-CURRENT GENERATORS, ELECTRICAL EQUIPMENT OF MESSRS. HARLAND & WOLFF'S SHIPBUILDING WORKS, BELFAST, IRELAND.

On account of the long and narrow shape of the building, the boiler room is placed at one end of the engine room. For this reason it has been necessary to carry the steam a considerable distance in order to get it to the engines; but to reduce the loss which this would incur, the steam main has been carefully lagged throughout its entire length. This pipe is carried down beneath the engine-room floor.

The chimney is a little over 180 feet high, and is placed near the centre of the boiler room. About two-thirds of the lower part is octagonal, the remainder

being circular. It is lined with firebrick 100 feet from the bottom. It was erected by the Custodis Chimney Construction Company.

The engine room is sixty-four feet wide and 171 feet six inches long. The height of the walls from the engine-room floor to the eaves of the roof is thirty-six feet six inches. All the steam and exhaust piping, as well as the water piping, the condensers and such similar auxiliary machinery, are arranged below the engine-room floor in a basement ten feet two inches high. Passages are left, giving access to any machine easily, and entrances are placed to each generator pit. In the engine room there are three horizontal Sulzer engines. One drives a three-phase alternator. The other two drive a three-phase alternator and a direct-current generator each. The engines are triple-expansion condensing. They have the high-pressure and one low-pressure cylinders in tandem on one side of the engine, and the intermediate and a second low-pressure cylinder on the other side. The high-pressure cylinders are 17.3 inches in diameter. The medium-pressure cylinders are 27.5 inches. The low-pressure cylinders are 31.5 inches in diameter. The stroke of the engines is 47.25 inches. The engines are fitted with Sulzer trip valves. They are rated at 1,000 horse-power each, though they will take an overload of 1,240 horse-power. The arrangement adopted, whereby one engine drives one three-phase alternator, and the other two two machines, was due to the requirements of night work, when a single engine is sufficient both for the alternating and direct-current supplies.

Engine House and Generating Station, Electrical Equipment of Messrs. Harland & Wolff's Shipbuilding Works, Belfast, Ireland.

The condensers are of the surface type, having 870 square feet of cooling surface. Cooling water is drawn from the Musgrave channel, which is a branch of Belfast harbor. For this purpose there are two twenty-inch inlets leading into a thirty-six-inch inlet pipe. Each of the inlets is provided with a double strainer box. The inlet pipe is carried to a large cast-iron tidal culvert built below the water level alongside the station. It is 116 feet long, ten feet wide, and six feet deep. This culvert enables the circulating pumps to draw water independently as if they were piped directly to the channel. The feed water is drawn from the hot well and delivered to storage tanks by two Weir pumps 6.5 inches by 5.5 inches in diameter by fifteen inches stroke. Each of these pumps can deliver 45,000 pounds of water per hour. This may be sent directly to the storage tanks which are placed above the storage battery room, which is next to the boiler house; or the water may be delivered to a purifier. The storage tanks contain sufficient water for twenty-four hours' run, should the town supply fail. The water is collected in a tank after passing through the purifier, and here any additional water is added, usually the pressure in the town mains being sufficient to introduce it. It is controlled by a float valve operated from these storage tanks. The feed water passes through two live-steam heaters. The make-up water drawn from the town mains passes through an exhaust steam heater, which brings it to about sixty degrees Fahrenheit. The final supply to the boilers is heated to 212 degrees Fahren-

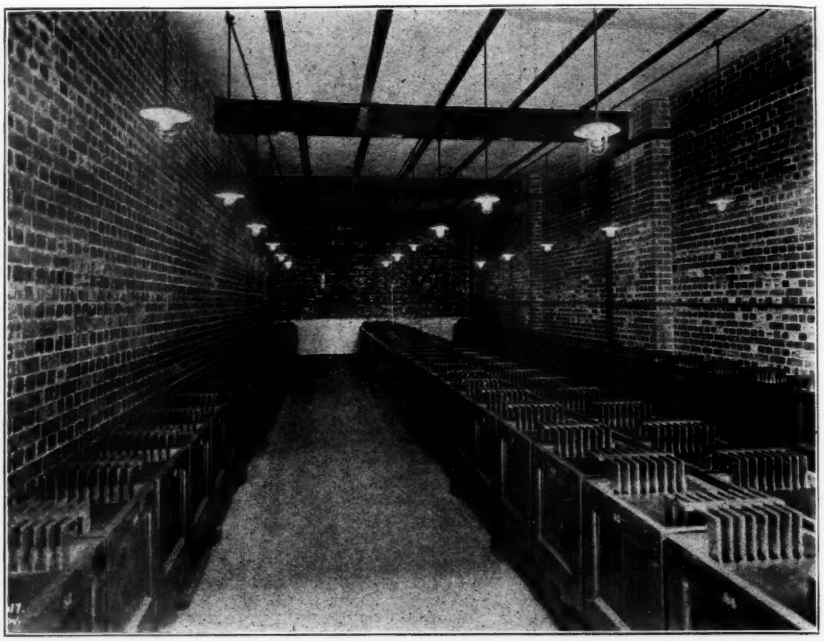
heit before it is introduced. Economizers were not installed in this plant.

In the basement is placed the condensing machinery. It consists of the surface condensers mentioned above, motor-driven centrifugal circulating pumps, air pumps, and the water pumps just mentioned.

The three-phase generators are of the revolving-field type, and were built by the Lahmeyer Electrical Company. They have sixty-four poles, and operate at 170 revolutions per minute. The outside diameter of the stator is twenty-four feet. The diameter of the rotating field is sixteen feet eleven and fifteen-sixteenths inches. They weigh thirty tons. The generators are star-wound and are rated at 650 kilowatts, 440 to 460 volts. They can carry an overload of 750 kilowatts.

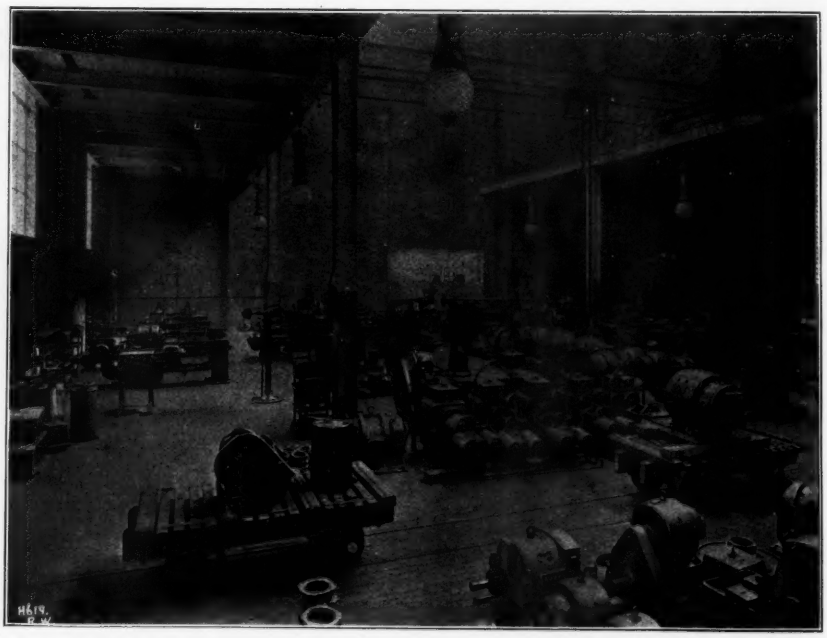
The direct-current generators are also rated at 650 kilowatts. They are thirteen feet eleven and one-half inches outside diameter. The armature is eight feet six and three-eighths inches in diameter, one foot and three-sixteenths of an inch wide. The commutator is seven feet five inches in diameter. These machines are separately excited at 220 volts, the exciting current being drawn from two sixty-kilowatt machines which feed independent bus-bars. These exciters also charge the storage batteries, which consist of 112 chloride cells rated at 1,530 ampere-hours at a nine-hour rate of discharge. All the motors driving auxiliary apparatus in the power-house are supplied from these batteries when starting the plant. This includes the motors for the traveling crane, and the barring motors for the main engines. The lighting supply for the power-house is also drawn from the same source. When in normal operation the main generators supply these auxiliary machines from the main power switchboard from one side of the three-phase system. A 120-kilowatt balancer, consisting of a synchronous motor-generator and two sixty-kilowatt, direct-current machines, can also be used for converting from alternating current to direct current, and *vice versa*, so that at times of very light load the power demand can be supplied by either one of two small high-speed generating sets. One of these is a three-phase machine rated at 350 kilowatts. The other is a 250-kilowatt, direct-current generator. There is in addition a motor-generator for charging the battery, and an automatic booster for the same purpose.

The switchboard is placed along a gallery running on one side of the engine room, supported by seven rectangular hollow columns which form, as well, ducts through which the generator leads are carried up to the board. The switchboard gallery is reached by a winding staircase at each end. The board is of the British Thomson-Houston Company's type. There are sixty-four marble panels seven feet six inches high, and two feet wide. The board is divided into sections accommodating the three-phase generators, the three-phase feeders, the continuous-current generators, the continuous-current feeders, both two and three-wire, and for power and lighting; the balancers, the storage battery and its boosters and the substations. There are twenty three-phase feeders in various parts of the works, and there are thirty-seven direct-current feeders, twelve of which are for lighting,



ACCUMULATOR HOUSE, ELECTRICAL EQUIPMENT OF MESSRS. HARLAND & WOLFF'S SHIPBUILDING WORKS, BELFAST, IRELAND.

and twenty-five for power. There are six 110-volt feeders which are carried throughout the works to a large number of substations, where portable motors may



REPAIR WORKSHOP, ELECTRICAL EQUIPMENT OF MESSRS. HARLAND & WOLFF'S SHIPBUILDING WORKS, BELFAST, IRELAND.

obtain power. These substations are principally for the shipbuilding slips. They are fed either from the station direct or from two motor-generators placed in outside substations. In addition to the

panels mentioned above, there are the usual instrument panels containing the ammeters, voltmeters, wattmeters, synchronizers and other necessary appliances.

The workshop, which adjoins the battery room, contains a large number of electrically-driven machine tools for making the necessary electrical and mechanical repairs for the power-house. This shop is two stories in height, the upper consisting of a gallery running around three sides. This gallery supports a five-ton traveling crane used for handling the heavy pieces of machinery. Adjoining the workshop are the test rooms and the general storerooms.

The engine room is beautifully finished with glazed tiling elaborately decorated. The walls have been arranged so as to conceal the rails upon which the crane travels. The engine-room floor is constructed of rolled steel joists and concrete, and is covered with octagonal tiles of white and green. The generator pits are lined with white glazed tiles. The floor of these pits is of concrete covered with granolithic cement. The main doors of the building are very ornamental, consisting of wrought-iron work surmounted by fixed screens. The entire finish of this room is rich and in good taste, and the whole building is as fire-resisting as it could be made.

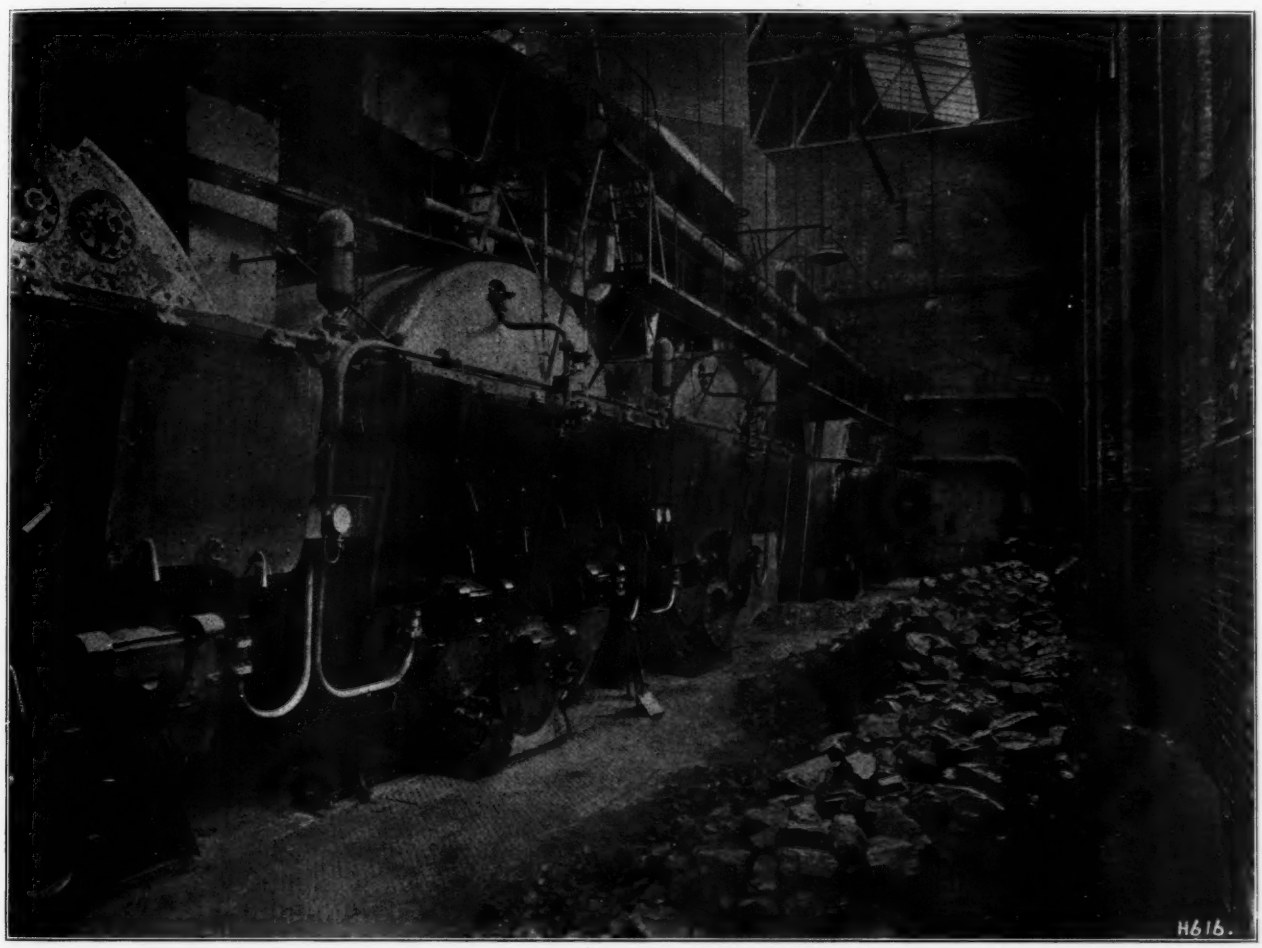
University of Illinois Test Car.

The track of the Illinois Traction System passes through the campus of the University of Illinois, about 1,500 feet of it being within the campus grounds. This system is now completed from Danville to Champaign, and next year will be completed to East St. Louis, making a continuous trackage of nearly 200 miles. The Hon. W. B. McKinley, president of the Illinois Traction System, and one of the trustees of the University of Illinois, has given the university the free use of the tracks of the system for experimental purposes.

The electrical engineering department of the university is now having an interurban test car built by the Jewitt Car Company, of Newark, Ohio. This car is thirty-four feet four inches over the corner posts, and forty-five feet overall. The car is vestibuled at each end, has a double trolley so that it can be run in either direction, and will weigh, with equipment, about 50,000 pounds. The interior is divided into a main compartment and an instrument room. The trucks are the Standard Steel Car Company's M. C. B. type, with six-foot six-inch wheel-base and thirty-three-inch rolled steel wheels furnished by the Standard Steel Works. The electrical equipment consists of four fifty-horse-power Westinghouse motors with Westinghouse unit switch system of control. The car is also equipped with Christensen independent air brakes and electric headlights. The instrument room will be equipped with a complete set of graphic recording instruments made by the General Electric Company and Ellicott Brothers, of London.

A car house containing a testing pit will be constructed at the university, where temperature tests of motor equipment can be made.

This testing car will be used to give students experimental work in connection with their course in electrical railways, and also for these and research work. It is expected that in this latter respect it will be particularly useful to the electrical railway interests of the country, as it will be available for any special investigations that may be desired. The car and equipment will be delivered in June, and will be ready for use at the opening of the next college year in September.



BOILER HOUSE, ELECTRICAL EQUIPMENT OF MESSRS. HARLAND & WOLFF'S SHIPBUILDING WORKS, BELFAST, IRELAND.

The Street Railway Association of the State of New York.

The twenty-third annual convention of the Street Railway Association of the State of New York was held at the new Fort William Henry Hotel, Lake George, N. Y., June 27 and 28. The following programme was carried out:

Tuesday, June 27, 9.30 A. M.—Meeting of the executive committee. Address of the president. Report of the executive committee. Minutes of the executive committee. Report of the treasurer. Reading of papers and discussion.

Tuesday, June 27, 2.30 P. M.—Reading of papers and discussion. Discussion on the question box. Appointment of nominating committee. Nomination of officers.

Wednesday, June 28, 9.30 A. M.—Reading of papers and discussion. Question box.

Wednesday, June 28, 1.30 P. M.—Reading of papers and discussion. Question box. Election of officers. Unfinished business. Adjournment.

Papers were read by H. W. Blake, on "Contrasts between Company and Municipal Ownership and Management of Public Utilities;" by J. N. Shannahan, on "Types of Interurban Cars;" by F. H. Peck, on "Uniform Standards of Examination of Railroad Employés;" by J. Harvey White, on "Publicity;" by T. W. Wilson, on "Suitable Cars for City and Suburban Service."

There was also presented a valuable report showing the income and operating expenses per car-mile of roads which are members of the New York state association. This report was compiled by H. M. Beardsley, of Elmira.

The following officers were elected:

President—R. E. Danforth, Rochester.

First vice-president—B. B. Nostrand, Peekskill.

Second vice-president—J. H. Pardee, Canandaigua.

Treasurer—W. W. Cole, Elmira.

Secretary—C. B. Fairchild, Jr., New York.

Executive committee—E. F. Peck, Schenectady; T. W. Wilson, Buffalo; Orin Root, Jr., New York; J. N. Shannahan, Gloversville.

The time and place of the next meeting were left with the executive committee.

The entertainment included a trolley ride over the line of the Hudson Valley Railway six miles north from the Fort William Henry Hotel to Warrensburgh. This is a scenic route through the foothills of the Adirondack mountains. Upon the return trip the cars proceeded to Glens Falls and Saratoga, returning to Lake George in the evening. There were also boat rides on the steamer Horicon, of the Lake George Steamboat Company, to Sagamore Hotel, where luncheon was served for the ladies.

The annual banquet was held on Wednesday evening at 7.30.

A number of manufacturers made exhibits at the Casino.

The Convention Dates of the National Electric Light Association.

An interesting list of convention dates of the National Electric Light Association has been prepared. It will be noted that the association held a winter and summer session from 1885 until 1891. From 1892 forward but one convention has been held each year. The dates are as follows: 1885, Chicago—winter; New York—summer. 1886, Baltimore—winter; Detroit—summer. 1887, Philadelphia—winter; Boston—summer. 1888, Pittsburg—winter; New York—summer. 1889, Chicago—winter; Niagara Falls—summer. 1890, Kansas City—winter; Cape May—summer. 1891, Providence—winter; Montreal—summer. 1892, Buffalo. 1893, St. Louis. 1894, Washington. 1895, Cleveland. 1896, New York. 1897, Niagara Falls. 1898, Chicago. 1899, New York. 1900, Chicago. 1901, Niagara Falls. 1902, Cincinnati. 1903, Chicago. 1904, Boston. 1905, Denver.

One of the old-timers, and also one who started at the Detroit summer convention and has not missed a convention since, is George T. Manson, general superintendent of the Okonite Company, New York city.

Eighth General Meeting of the American Electrochemical Society.

The board of directors of the American Electrochemical Society has decided to hold the eighth general meeting at Bethlehem, Pa., in response to an invitation from the president of Lehigh University. The time of the meeting will be September 18, 19 and 20. A good programme will be prepared, and as there are many interesting points in and around Bethlehem, it is anticipated that this will be a very successful convention.

The board is in receipt of a communication notifying it that there will be a competitor for the Frenzel prize. It was moved and carried that a time be set—namely, the next annual meeting—at which applications for the prize will be considered.

Report of Leeds Municipal Electric Plant.

United States Consul Walter C. Hamm at Hull, England, reports that the accounts of the electric department of the Leeds corporation for the financial year ended March 25, 1905, have just been made public. The gross profit amounts to $280,260, against $227,685 in the financial year 1904, after allowing for interest and redemption there is a surplus of only $1,410, as compared with $17,150 surplus in 1904. The receipts from sales for lighting have increased from $334,075 to $367,985, and the receipts for power from $44,535 to $54,095. No explanation is given as to why the interest and redemption fund was so much larger in 1904-5 than in 1903-4, reducing the net profits to a nominal figure, notwithstanding the fact that the gross profits were over $33,000 larger.

German Electrical Products and the New Treaties.

The Association for Protecting the Interests of German Electro-Technics, says United States Consul-General Guenther, Frankfort, Germany, at its annual meeting, May 2, 1905, at Berlin, adopted a resolution as follows:

"This association notes the results obtained in our new commercial treaties with Switzerland, Italy, Servia, and Roumania, which lead us to presume that the exportation of German electrical products thither will maintain its volume as heretofore. The association, however, deplores the very considerable tariff increases made by Austria-Hungary, and the prohibitive character of the most important tariff schedules of Russia, in whose markets German dynamos, electric motors, and cables will henceforth have no sales. The total German exportation to Russia will be diminished by one-third. The association urgently requests the German federal and state authorities to use all efforts for making up for this diminished exportation by getting better terms in the treaties to be negotiated. It is to be borne in mind that during late years numerous and extensive electrical manufactories have been established in various countries, and these, working under more favorable conditions, have either made it very difficult for us to compete with them or threaten to tie us up altogether in the near future."

According to this, the future offers opportunity for American electrical enterprise in many European countries where hitherto the Germans have dominated. The manufacturers of the United States have decidedly superior advantages in many ways over German manufacturers, but can only make them available abroad by personal effort and business tact.

ELECTRICITY IN A MALLEABLE IRON FOUNDRY.

BY H. P. KERNOCHAN.

Electric power, transmitted at 20,000 volts from the water-power generating stations at Spiers Falls, N. Y., and Mechanicsville, N. Y., and stepped down for distribution to 2,200-volt, forty-cycle, three-phase current in the Watervliet substation of the Hudson River Water Power Company is now furnished to the Troy Malleable Iron Company, Watervliet, N. Y., for power and lighting. The electric motor applications comprise individual and group drives and replace one 225-horse-power and one 125-horse-power steam engines, about 350 feet of main line shafting, and a large number of countershafts and belts. All machinery used in the tumbling and rolling rooms, in the pattern and machine shops, and for operating elevators, fans for the cupola furnaces and for the ventilating systems, is now electrically driven. The lighting of the plant, which includes a floor area of 157,000 square feet, comprises both arc and incandescent lamps arranged and distributed according to the various requirements.

Much valuable space was formerly taken up by the belts and pulleys used in the mechanical transmission of the power. Several of the pulleys were six feet in diameter, and in many cases it was impossible to locate the machines to the best advantage for turning out the work, owing to the necessity of placing them as near the main line of shafting as possible in order to keep down friction losses. Such losses, nevertheless, amounted to about eighty-five horse-power, as determined by indicator cards taken in anticipation of the introduction of electric drive.

To step down the 2,200-volt local distributing pressure three General Electric 100-kilowatt delta-star-connected type H transformers, giving 220 volts secondary between phases and 127 volts between each phase and the neutral, have been installed in a small brick building conveniently located. From the transformers the current is carried through a four-pole, single-throw, carbon break lever switch, with fuses, to the four bus-bars located back of the switchboard, which is installed in the old engine room.

The board is of black enameled slate, and consists of five power circuit feeder panels, each for a motor capacity of about sixty horse-power and of six lighting circuit feeder panels of about the same capacity. The carbon break lever switches which control the feeder circuits are installed on the front of the panels, while the fuses are mounted back of the panels. For measuring the total power consumption there are furnished by the Hudson River Water Power Company three single-phase Thomson recording wattmeters. These meters are fed by current transformers inserted in the main leads between the four-pole main lever switch and the buses, and are mounted on top of the lighting feeder panels.

The total motor equipment of the plant consists at present of thirty-nine General Electric 220-volt, forty-cycle, three-phase form K induction motors, aggregating 306.5 horse-power and replacing 350 horse-power in the two steam engines formerly used. All of the motors have a rated (synchronous) speed of 1,200 revolutions per minute, except one twenty-horse-power motor which has a speed of 800 revolutions per minute. Each motor of a capacity less than five horse-power is equipped with a triple-pole, single-throw carbon break lever switch, with fuses, mounted in a wooden box lined with asbestos. All motors of five horse-power and over, except the five-horse-power elevator motor, are started by the compensators equipped with oil break starting switches and fuses. A triple-pole, single-throw air-break switch is inserted in these motor circuits, enabling the compensator to be entirely disconnected from the mains for repairs, for making changes in the low-voltage taps, etc. The fuses and disconnecting switches for each motor are mounted on the wall in a protected wooden box, which is placed immediately above the starting compensator. The motors for elevator service have a high-resistance rotor in order to give high-starting torque.

The elevator mechanism is of the common factory type, with two loose pulleys and one tight pulley and belt shifter operated by hand for starting, and stopped automatically at the ends of the run. By a simple connection of a triple-pole, double-throw switch on each floor, the motor may be started, under no load, from either floor, and it is then only necessary to throw the belts by means of the elevator mechanism in order to start the elevator. This method is extremely simple electrically and absolutely protects the motor from heavy overloads, at starting, which may arise from improper throwing of switches. Pilot lamps are used to indicate when the motor is connected to the line. These features have proved very satisfactory, since the electric motor is now operated only when the elevator is actually in use, while with the old arrangement the shafting was continually running although the elevator might be idle for long periods.

None of the motors are inverted, but all of them are placed on platforms mounted overhead on the trusses forming a part of the building structure. This arrangement facilitates inspection, and the weight thus carried by the trusses does not exceed that of the shafting, pulleys, etc., that have been displaced by the introduction of electric drive.

In deciding upon the size of the motors to be used in group drives, the basis of calculation for each group was the horse-power necessary to drive the maximum number of machines, in the group, that would be in operation at one time. The grouping was arranged to accommodate not only the existing layout of machines but also the progression of the work through the shops. No attempt was made to duplicate apparatus or circuits to provide for breakdowns, except in the case of the furnace fans. These fans may be driven from the old engine, which is kept in reserve for emergency.

The lighting of the whole plant, including office, shops and yard, is effected by 127-volt alternating current, and special care has been taken to obtain a well-balanced load on the lighting circuits.

Thirty General Electric 7.5-ampere multiple type alternating-current enclosed arc lamps and 600 sixteen-candle power incandescent lamps are used, supplied from a four-wire network. The distribution of the arc and incandescent lamps was made the subject of a good deal of study, and a subdivided system of control was installed whereby each arc is provided with an individual switch and fuse, and each group of six or eight incandescent lamps with a fuse. By this subdivision complete flexibility of the lighting has been secured, and at the same time the number of lamps burning at any time is reduced to those actually needed, under the supervision of the section foremen.

By the introduction of electricity into this plant the expense for power has been reduced thirty per cent, while convenience and economy of manufacture have been greatly improved, and valuable space has been reclaimed. The plant is equipped with General Electric Company apparatus throughout. All of the installation work, including the wiring and the placing of the motors, was done by the New England Construction Company.

A NEW CARBON FILAMENT.[1]

BY JOHN W. HOWELL.

I have the pleasure of presenting to you some data on a new carbon filament, which has characteristics so differing from those of any previously known filament as to seem to indicate that it is a new form of carbon. Besides being very interesting on account of its physical characteristics, this filament is of considerable value on account of its much better life or efficiency, as compared with the carbon filaments heretofore known. This new filament is the result of work done in the research laboratory of the General Electric Company, and in the laboratory of the lamp works at Harrison, N. J.

In briefest outline, the new characteristics of the filament may be said to be due to the proper application of excessively high temperatures to the ordinary carbon filament. The value of the product is determined by the conditions under which the high temperatures are applied.

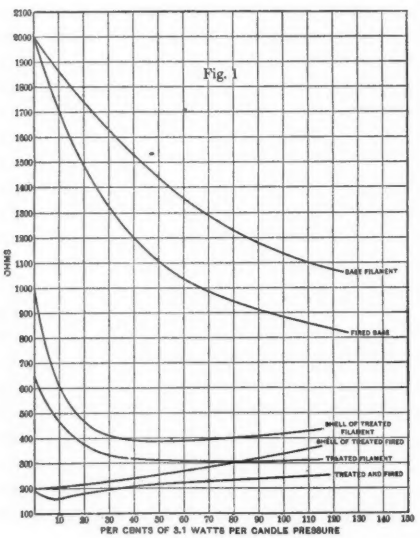


FIG. 1.—RESISTANCE OF FILAMENTS AT DIFFERENT TEMPERATURES.

It is well known that an ordinary incandescent filament in an evacuated lamp may be heated to excessive temperatures by the application of high current without producing any beneficial change in the filament. To produce the effects described in this paper the heat is externally applied to treated filaments at atmospheric pressures. The simple application of the highest attainable temperatures to the plain carbonized cellulose fibre, *i. e.*, the so-called "filament base," is also incapable of producing any considerable change in the filament. This high temperature treatment of the base is, however, a beneficial step in the process here described.

Before describing the new process, it may be well to recall the steps by which the standard filaments are made. A solution of cellulose is squirted through a die into a liquid that hardens the cellulose. The resulting fibre is dried, then shaped into the desired form for the finished filament and heated in a muffle until carbonized. In this process the highest temperature of a gas furnace is employed. The product at this point is called a "base filament." The base filaments are usually separately heated by a current passed through them while they are surrounded by an atmosphere of hydrocarbon vapor, and in this way a coat or shell of graphite is deposited upon them. They are then said to be treated filaments. The best quality of standard carbon incandescent lamps of to-day owe their superiority to the use of treated filaments.

In attempting to graphitize carbon filaments it was discovered that treated filaments undergo very remarkable changes when subjected to the highest possible temperature of an electric-resistance furnace. The furnace consisted of a carbon tube, held at the ends by large water-cooled copper clamps; the tube was imbedded in powdered carbon to prevent its combustion. The filaments were packed in small, cylindrical carbon boxes, which were fed into the heated tube. The temperature was usually between 3,000 and 3,700 degrees centigrade.

Under such firing the ordinary treated filament changes in appearance; its graphite coating looks as though it had been melted, and its specific resistance is greatly reduced. The resistance of one of these filaments, measured at ordinary temperature, may be reduced as much as eighty per cent by the firing.

The curves representing the resistance at different temperatures are also remarkable. Fig. 1 shows curves of resistance and temperature of a regular base filament, a base filament fired, a regular treated filament, a treated filament fired, a shell of regular treated filament, and a fired shell.

The resistance in ohms is plotted against the temperature, as indicated by the percentage relation of the pressure on the filament to the normal pressure at which the filament has an efficiency of 3.1 watts per candle.

The curves show a more rapid fall in resistance of the base filament after firing, but little change in the character of the curve.

The change produced in the treated shell by firing is very great, the cold resistance being reduced from 1,000 to 200 ohms, while the great change in the character of the curve of the fired shell brings the hot resistance of the two shells nearly together.

The resistance curve of a fired treated filament depends upon the relative thicknesses of base and coating and upon the temperature of firing. Figs. 2 and 3 show curves of filaments fired at five different temperatures and of a similar filament that has not been fired. In Fig. 3 the resistances are shown in percentages of the cold resistances, and in Fig. 2 the actual resistances are shown.

These filaments were heated in the carbon-tube resistance furnace. They were enclosed in a cylindrical carbon box, placed inside the tube, one end of which was left open for observation. An indication of the temperature was obtained by looking directly into the open end of the tube at the box holding the filaments, and holding in the line of vision the filament of an ordinary fifty-volt lamp, the temperature of which was adjusted until the filament became invisible against the incandescent carbon box. The pressure on the lamp was then observed and the box of filaments taken out.

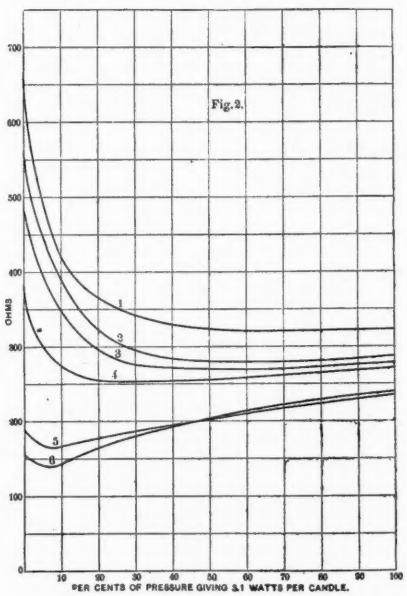


FIG. 2.—ACTUAL RESISTANCE OF FILAMENTS FIRED AT FIVE DIFFERENT TEMPERATURES.

Curve No. 1 is the resistance curve of a regular treated filament.

Curve No. 2 is the curve of a similar filament heated in the tube to a temperature corresponding to the temperature of

[1] A paper presented at the twenty-second annual convention of the American Institute of Electrical Engineers, Asheville, N. C., June 19-23, 1905.

a carbon filament operating at 153 per cent of its normal pressure, or at 125 candles for a normally sixteen-candle-power lamp.

Curve No. 3 is the curve of a filament fired at a temperature corresponding to the temperature of a lamp at 161 per cent of its normal pressure, or at 163 candles.

Curve No. 4, 183 per cent of normal pressure, or at 230 candles.

Curve No. 5, 200 per cent of normal pressure, or at 280 candles, for a sixteen-candle-power lamp.

Curve No. 6 is the curve of a filament heated hotter than No. 5. The temperature was not measured by this method for fear of breaking the comparison lamp.

An attempt was made to measure the temperatures by means of an optical pyrometer (Wanner) which indicated temperatures up to 3,700 degrees centigrade at the highest heats.

Fig. 4 shows the resistance curve of a filament made from a thin base having quite a thick treatment. This shows a resistance increasing to 250 per cent of its cold resistance.

The change in the resistance curve of this coating from negative to positive seems to be due, in part at least, to the action upon the shell of some substance driven out of the base filament by the high temperature. This is indicated by the

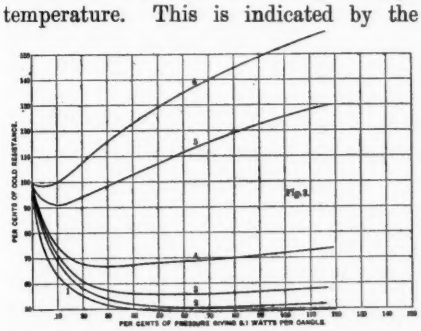


FIG. 3.—COLD RESISTANCE OF FILAMENTS FIRED AT FIVE DIFFERENT TEMPERATURES.

considerable change in the curve of a treated fired filament produced by heating the base filament to the same high temperature before it was treated and then reheated.

Fig. 5 shows resistance curves of carbons fired at the same temperature after treating, but with the base fired at different temperatures before treating. The base filament in curve A was unfired; in B, C, D, and E the base was fired at successively higher temperatures.

It will be observed that the curves made from filaments, the bases of which have been heated to high temperatures before being treated, are much less positive than the others. The conclusion that the effect is produced by material being driven out of the base seems to be borne out by the fact that during the preliminary heating of the base at high temperatures it loses practically all of its mineral ash constituents, and also by the fact that, if some of the elements that the base loses in its high heating be separately placed in the furnace with the treated filaments, effects are produced similar to those observed when the base has not been previously heated.

The effect of some agency besides heat is also indicated by the fact that the lamp filament used in the temperature observations, although maintained at the same temperature as the filaments in the furnace, and for a sufficiently long time, showed no indications of such a change as was produced in the filaments in the furnace.

The appearance of a filament fired both before and after treating is very different from that of one fired after treating only. The former has a slightly pebbled appearance, as seen through a microscope, and a rather dull-gray color.

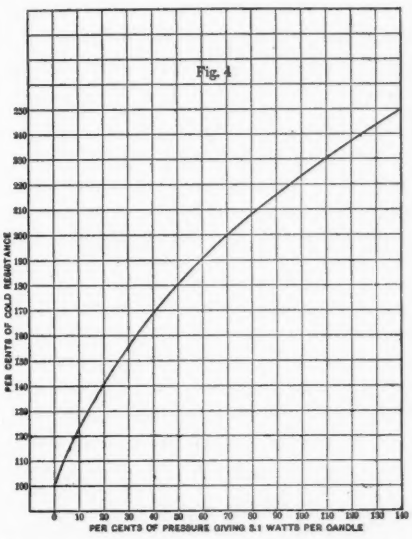


FIG. 4.—FILAMENT OF THIN BASE, HAVING A THICK TREATMENT.

The single-fired treated filament is generally very much blistered, many blisters extending outward a distance greater than the diameter of the filament. These blisters indicate an outflow of gas from the base when the shell was in a soft condition. The surface of the filaments is highly lustrous.

The specific-resistance of the highly heated coating has been found to be as low as 0.00006 ohm per cubic centimetre, which is very much lower than the specific resistance of any other known form of carbon or graphite.

Its specific gravity is also much higher than it was before heating.

Its changed nature is also indicated by its toughness and flexibility. The coating of a double-fired filament may be pulled off in short tubular sections, which if pressed flat will spring back to their original form when the pressure is removed. The same coating before being fired is comparatively brittle, and will break with very little pressure. On account of the positive resistance curve and physical characteristics of these filaments, they have been given the name "metallized filaments."

The treated coating on filaments, even before firing, is graphite, as determined by the chemical test established by Berthelot—the production of graphite acid (a yellow insoluble substance) when treated with a mixture of anhydrous nitric acid and potassium chlorate. Ordinary carbon is dissolved by these reagents. The coating on the treated filament has also the greasy feel of graphite, and gives the characteristic mark of graphite on white paper.

After being heated to high temperatures in the electric resistance furnace these characteristics continue and the chemical action is much more marked.

Metallized filaments blacken the lamp bulb very much less than ordinary filaments. This may be due to the removal from the former of practically all the mineral ash and other impurities, or it may be due to the changed character of the carbon itself.

Bamboo, coated by dipping in a solution of asphalt, is altered by firing, the coating changing to graphite and giving the characteristic positive curve.

Silk dipped in a sugar solution also gives the same result.

The base of a metallized filament, from which the treated coating has been removed, when mounted in a lamp has been

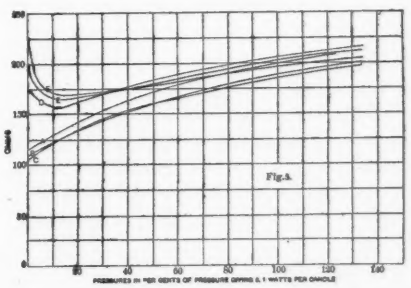


FIG. 5.—BASES FIRED AT FIFTY DIFFERENT TEMPERATURES BEFORE TREATMENT, CARBONS FIRED AT SAME TEMPERATURE.

found to give the resistance curve of a fired base. Pieces of the coating, about 1.5 inches long, mounted in lamps, have been found to give the strongly positive resistance curve that is characteristic of the metallized filament. These observations show that the change is practically all in the treated coating and not in the base.

Metallized filaments, as above described, are much more stable at high temperatures than ordinary carbon filaments.

The most effective carbon filament lamp now in general use operates at 3.1 watts per candle and under accurate test conditions gives a useful life (to eighty per cent of its initial candle-power) of about 500 hours. At the present time metallized filaments that give the same useful life at about 2.5 watts per candle are being produced with a fair degree of uniformity.

OPERATION OF TRANSFORMERS AT VARYING FREQUENCIES AND VOLTAGES.[1]

BY M. A. SAMMETT.

The alternating-current transformer holds a prominent place in modern central stations. In the investment of the plant it constitutes a considerable portion of the companies' outlay, and where the supply of individual customers is done by the aid of step-down transformers, the total kilowatt capacity in transformers is equal to three and even four times that of the capacity of the generating plant.

This wide application of transformers commands a thorough understanding of transformer characteristics, and it is gratifying to note that of late manufacturing concerns are making an effort to disseminate useful information and thus place in the hands of the operating engineer data which will enable him to have a more complete understanding of the various types of transformers, methods of testing same for losses, regulation, proper rating, etc.

In view of the fact that the subject of testing has been dealt with in convention papers on previous occasions, I have in this instance selected a subject which will confine itself to characteristics expressing the effect of varying frequency and variable voltage on transformer operation. The choice of such characteristics suggested itself on the one hand by conditions peculiar to hydroelectric power development so very extensive in Canada, and on the other hand by the tendency of consolidation, a tendency of international character, aiming at the centralization of the same industries under one management.

Let us take up first the question of influence of variable frequency on the operation of transformers. In various hydroelectric plants throughout the Dominion, wherever the severe winter generally causes a considerable diminution of the effective head on account of the ice formation in the tail-race and forebay, the operating engineer is sometimes called upon to resort to extreme means in order to carry the station load at a lower frequency. Often engineers laying out a plant for low water heads would, providing for such an exigency, specify the generators to be designed with a weak field and low magnetic density in the armature laminations. Then, when the emergency does come and there is no steam plant to fall back on for running the two plants in multiple and thus hold the entire system at the proper frequency the lower voltage, resulting from low speed, will be raised by increasing the field excitation, thus full normal voltage will be secured and as far as the generator potential is concerned normal conditions will be restored. Let us suppose there is a quantity of water sufficient to carry the load at a lower speed and investigate the effect of lower frequency on transformers intended to operate at a given higher frequency.

It would be impossible to give exact data as to how far it would be permissible to go in lowering the frequency of a given plant without endangering the very life of the apparatus of the system.

This would depend on the characteristics of the generators as well as the various transformers of the system. Granted that the generating machinery was designed to meet such conditions, would the same apply to standard apparatus such as step-down transformers for lighting or motor service? What criterion can we use in order not to overstep the safety limit? As stated before, the individual characteristics of the apparatus must be known in every case in order to give a definite answer to this question, and a treatment of general principles involved will serve to illustrate the relation between the frequency and transformer performance and to demonstrate that independence.

We shall not go into the minute analysis, but concern ourselves only with such points as are of interest to us as central station men, leaving the finer details to the designing engineer.

The points we are chiefly interested in are those of the effect on the iron losses (the copper loss remaining practically constant at any frequency), the exciting current and regulation, points that directly affect the efficiency of the apparatus and consequently the efficiency of the entire system. The difference of iron losses at different periodicities will affect the full load as well as the all-day efficiency of the plant. The difference in the exciting current will be responsible for a considerably increased no-load current.

We shall also determine the effect of lowering of the frequency on the regulation in order to find their relation. The question of regulation is an important one to central stations, as the useful life of incandescent lamps depends altogether on the voltage of the circuit the lamps are connected to, and this voltage must be maintained constant, requiring close regulation.

To begin with, the first mentioned variable, that of the iron loss, is, as you all know, composed of the so-called hysteresis or lag loss due to molecular friction caused by the lagging current of magnetic induction with relation to the magnetizing force as the iron goes through a cycle of magnetization, and the eddy current loss, which is a loss of energy consumed, is setting up induced currents in the iron.

Mr. C. P. Steinmetz, who carried on extensive investigations in connection with hysteresis and eddy current losses, arrived at certain empirical formulæ which check very close with actual results, and we shall make use of these formulæ to get a clearer understanding of the relation between the various quantities which determine the iron loss.

HYSTERESIS LOSS.

In its simplest form the formula reads as follows:

$$\text{Hysteresis} = P_{H2} = x\ B^{1.6}$$

which is the loss in ergs per cycle for each cubic centimetre of iron. In this expression x is a constant indicating the quality of iron, depending on the chemical constituents entering it and also on the physical treatment in the manufacture of same. Applying the above expression to any transformer, in order to determine the hysteresis loss the formula will be modified by adding two more factors, namely, the volume of iron in cubic centimetres and the factor representing frequency.

Hence $P_H = x\ VNB^{1.6}$ in ergs or if expressed in practical units $P_H = x\ VNB^{1.6} \times 10^{-7}$ watts.

Where

x = constant for given quality of iron.
V = volume in cubic centimetres.
N = frequency in cycles per second.
B = induction per square centimetre of iron.

EDDY CURRENT LOSS.

The energy lost in eddy current reads as follows when expressed in practical units:

$$P_E = EVN^2 B^2 10^{-7}$$

where E = eddy current constant.

V, N and B = volume, frequency and density expressed in the same units as those in the hysteresis formula. The eddy current constant E depends on the thickness of the laminations of iron and frequency, varying directly as the square of the thickness, the square of the frequency and directly as the first power of

[1] Paper read at the convention of the Canadian Electrical Association, Montreal, Canada, June 21-23, 1905.

the specific electric conductivity of the iron. Expressed numerically it reads:

$$E = \frac{(3.14)^2}{6} Z^2 y 10^{-9} = 1.645 Z^2 y 10^{-9}$$

where Z = thickness in centimetres of laminations.

y = specific electric conductivity of iron in megohms.

Hence

$$P_H = 1.645 Z^2 y VN^2 B^2 10^{-16} \text{ watts.}$$

The combined loss of hysteresis and eddy current generally called core loss will be expressed as follows:

$$\text{Core loss} = x \frac{VNB^{1.6}}{10^7} + \frac{1.645 Z^2 y VN^2 B^2}{10^{16}} \text{ watts.}$$

Of these the eddy current loss at commercial frequencies is the smaller one of the two, and as it varies directly with the square of the frequency and induction, the higher the frequency and induction the higher the loss due to eddy current. In standard transformers of good make the eddy loss varies from forty-five per cent of the combined iron loss at 125 cycles to that of fifteen to twenty per cent with a frequency of twenty-five cycles.

Frequency.	Hysteresis Loss. Per Cent.	Eddy Current Loss. Per Cent.
125	55	45
60	70	30
25	80-85	15-20

In order to be able to calculate the change in the iron losses by the aid of the empirical formula given above we shall have to make use of the fundamental formula in alternating-current work, the basic formula which expresses the relation between different quantities as they enter into the making of the transformer.

$$E = \sqrt{2} \times 3.14 \times TNAB 10^{-8} \text{ or } B = \frac{E 10^8}{\sqrt{2} \times 3.14 \times TNA}$$

where

T = turns of primary or secondary winding.

E = voltage corresponding to turns of winding given above.

A = cross-section of iron in square centimetres.

B = induction per square centimetre.

Having to deal with transformers in operation, all quantities with the exception of frequency and consequently magnetic density are fixed and we may combine them all under one constant

$$\frac{E 10^8}{\sqrt{2} \times 3.14 \times TA} = k.$$

This will reduce the formula to $B = k \frac{1}{N}$

Thus we see that magnetic density is inversely proportional to the frequency, that is to say, with a frequency half that of the original or normal frequency the density will be double normal density, and with frequency twice as high as normal frequency we will have half normal induction, or with a change from sixty to thirty cycles the induction will be double what it was at sixty cycles.

Referring to formula of hysteresis $P_H 60 = x \times V \times N \times B^{1.6} \times 10^{-7} = x \times V \times 60 \times B^{1.6} \times 10^{-7}$; when frequency is changed to 30 cycles $P_H 30 = x \times V \times 30 \times (2 B)^{1.6} \times 10^{-7} = x \times V \times (30 \times 2) \times 2^{0.6} \times B^{1.6} \times 10^{-7} = x \times V \times 60 \times B^{1.6} \times 10^{-7} \times 1.516$,

which means that a reduction in frequency from sixty to thirty will increase the hysteresis loss 51.6 per cent.

The eddy current loss in a given transformer, as will be shown by the equations below, is a constant loss, depending on the voltage alone. The two variables, namely, frequency and induction, entering the expression as squares of the inverse quantities, neutralize each other.

$$P_E 60 = \frac{1.645 Z^2 y B^2 N^2 V}{10^{16}}$$

$$P_E 30 = \frac{1.645 Z^2 y (2 B)^2 (\tfrac{1}{2} N)^2 V}{10^{16}}$$

Hysteresis varying in the inverse ratio

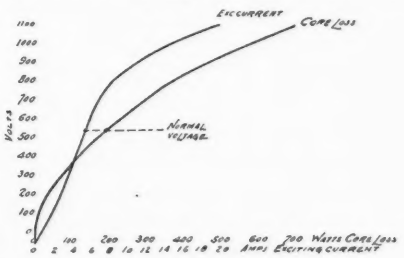


FIG. 1.—CORE LOSS AND EXCITING CURRENT OF TWENTY-KILOWATT, SIXTY-CYCLE, 2,200-500-VOLT TRANSFORMER.

of frequencies raised to the power 0.6 we have the following relation.

New hysteresis is equal to normal hysteresis.

$$\left(\frac{\text{Normal frequency}}{\text{New frequency}}\right)^{0.6}$$

This expression will be helpful in enabling us to find the constants of conversion from existing frequencies to any new frequency.

Taking the hysteresis at 133 cycles as unit, we get the following constants of conversion:

Frequency.	Hysteresis.	Eddy Current.
133	1.0	0.82
125	1.038	"
100	1.187	"
66	1.522	"
63	1.566	"
60	1.612	"
50	1.799	"
40	2.056	"
33	2.308	"
30	2.443	"
25	2.726	"

In this table the eddy current loss is given as eighty-two per cent of the hysteresis loss at 133 cycles and will remain a constant for all frequencies.

This table shows that a decrease in frequency will result in an increase in hysteresis and consequently in a higher temperature of the transformer iron. In oil-immersed as well as dry self-cooling transformers this increased temperature rise of the iron will cut down the current-carrying capacity of the transformers, and what would under normal conditions be called normal load would with a lower frequency be an overload and may cause the burn-out of the transformer.

All standard transformers for lighting and motor service are manufactured so as to operate at a considerable range of frequencies and they are generally subdivided into two classes, "the high frequency" and "low frequency transformers." The former adopted for use on circuits from 60 to 140 and the latter from 40 to 60 cycles. While they will be guaranteed to operate satisfactorily within the ranges given above, they will have to be re-rated as the various iron losses at different frequencies will increase the temperature at which the transformers operate, hence diminish their capacity. This consideration will add more weight to the importance of selecting transformers with a low core loss, a consideration so very vital for the all-day efficiency of a plant with a heavy lighting load.

Taking up now the question of unification of two existing systems operating at different periodicities the conclusions arrived at in this paper would at once suggest that the lower frequency should be raised whenever possible and the higher frequency should be made standard. Such a change would decrease the energy dissipated in the iron of transformers of lower periodicity and they would operate at a temperature below that of previous normal conditions. While this policy should always be followed by hydroelectric plants wherever conditions permit of such a change, it is of still greater importance to steam-generating plants where high core loss resulting from lowering of the frequency, besides the fact of decreased transformer load carrying capacity means also an increased coal consumption, two factors detrimental to the economy of the plant.

Often, however, local conditions make it impossible to raise the frequency above a given point and then a compromise frequency would be the best way out of the difficulty.

We will now take the figures, given by one of the largest manufacturing con-

cerns as guarantees of iron and copper losses of their standard transformers, and applying the constants of conversion given in the table, determine the effect of a change from sixty cycles to that of forty cycles.

High frequency transformers sixty cycles, 2,080-104-208 volts.

K. W.	Core Loss in Watts.	Copper Loss in Watts.	Total Loss in Watts.
1.0	39	27	66
3.0	62	65	127
5.0	95	94	189
7.05	117	125	242
10.0	156	147	303
15.0	202	215	417
20.0	232	290	522
25.0	258	327	585
30.0	302	394	696
40 Cycles = 2.080-104-208 volts. K = 1.186.			
1.0	46.5	27	73.5
3.0	74.0	65	139.0
5.0	113.0	94	207.0
7.05	139.0	125	264.0
10.0	185.0	147	332.0
15.0	240.0	215	455.0
20.0	276.0	290	566.0
25.0	307.0	327	634.0
30.0	359.0	394	753.0

Thus we see that the lowering of the frequency from sixty to forty will result in an iron loss of a thirty-kilowatt transformer of fifty-seven watts higher than prior to the change, and in order to keep the temperature within the same limits it would be necessary to decrease the current-carrying capacity by the same number of watts. A reduction of fifty-seven watts will bring the copper loss to 337 watts or to 85.5 per cent originally normal copper loss and consequently to 92.5 per cent of transformer capacity.

A change to a system of thirty cycles will give the following losses:

K. W.	Core Loss in Watts. K = 1.34.	Copper Loss in Watts.	Total Loss.
1.0	52.5	27	79.5
3.0	83.0	65	148.0
5.0	127.0	94	221.0
7.05	157.0	125	282.0
10.0	209.0	147	356.0
15.0	271.0	215	486.0
20.0	311.0	290	601.0
25.0	346.0	327	673.0
30.0	405.0	394	799.0

Taking the same thirty-kilowatt transformer we find the core loss increased by 103 watts. A corresponding decrease in copper loss will reduce the latter to 292 watts or 74.1 per cent normal copper loss, thus making the load carrying capacity of the transformer in kilovolt-amperes only eighty-six per cent that of normal.

The above figures giving the per cent normal load capacity are, comparatively speaking, favorable as compared to the large station transformers which are designed with an iron loss considerably in excess of the copper loss, sometimes differing as much as to be twice the loss in the copper. You will readily see then that the capacity of the apparatus under these conditions would be greatly reduced with the increase in iron loss.

Assuming the core loss to be twice as high as the copper loss when operating at sixty cycles, what should be the transformer rating at thirty cycles? Core loss at 30 = core loss at 60 × 1.34. (1.34 is constant derived from our table, including both the hysteresis and eddy current losses.) This increase will make the energy dissipated in the iron 2.68 x, where x is watts loss in the copper (instead of $2x$) and the energy permissible to be dissipated by the coils to make up the same total energy loss of $3x$ for the same operating temperature will be 0.32 x. The kilovolt-ampere capacity varies directly as the square root of the energy lost in the winding. Consequently the transformer capacity = $\sqrt{0.32} = 0.565$ or 56.5 per cent normal capacity.

EXCITING CURRENT.

The exciting current is the vectorial sum of the magnetizing or wattless current and the energy current supplying the hysteresis loss. The two components are at right angles to each other and the exciting current I can be expressed as

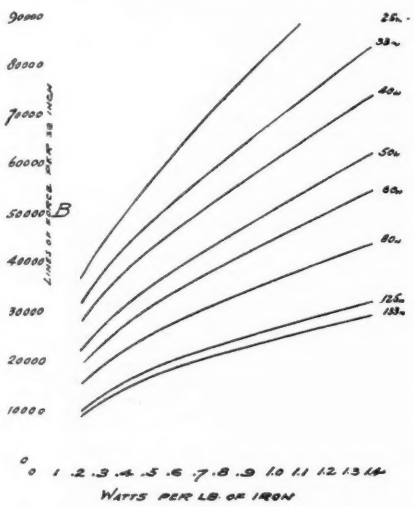


FIG. 2.—CORE LOSS IN WATTS PER POUND OF IRON.

$$I_0 = \sqrt{I_M^2 + I_H^2}$$

where I_M = magnetizing current
I_H = hysteresis current

I_M in well designated transformers is equal to the hysteresis current, and this can be found by diving the hysteresis watts into the impressed voltage.

Hysteresis watts, as we have found before, are equal to $P_H = x\ VNB^{1.6} \times 10^{-7}$; giving for the hysteresis current

$$I_H = \frac{x\ VNB^{1.6}\ 10^{-7}}{E}$$

The magnetizing current being equal in magnitude to the hysteresis current, the exciting current will be equal to

$$1.41\ x\ \frac{VNB^{1.6}}{E\ 10^7}$$

Thus we find the exciting current varies as the 1.6 power of magnetic induction, which in its turn varies inversely as the frequency. So that a lowering in frequency will increase the exciting current and naturally decrease the no-load efficiency of the transformer as well as the entire plant.

REGULATION.

By regulation is meant the difference between the secondary voltage under conditions of load and with secondary coils open circuited, when a constant primary voltage is impressed. The regulation of a given transformer with a non-inductive load is so much different than the regulation when the load is inductive that it is essential to specify the nature of the load. It would be well to state here that in a given station operating synchronous motors the lowering of the frequency would be prohibitive and even in the case of induction motors the change of speed can not be allowed to fall more than five or ten per cent below the normal, which is from two to five per cent lower than the synchronous speed. The only inductive load possible to be carried at frequencies below normal would be that of series alternating enclosed arc lamps. These operate as a rule at sixty cycles, but will operate satisfactorily at fifty cycles, as is the case in many plants in Europe. Fifty cycles will serve as a limiting line, since at lower periodicities the arc becomes unstable. In incandescent lighting the critical point is reached at about twenty-five cycles and, therefore, plants operating at forty cycles may, other conditions permitting, drop in frequency to that point and yet give satisfactory service.

Confining ourselves to non-induction load only, how would the regulation be affected with a frequency below normal?

$$\text{Regulation in per cent} = 100 - \frac{[100 \times \text{secondary volts full load}]}{\text{Secondary volts no load}}.$$

Regulation when expressed in terms determining the various values in the transformer can be expressed as follows:

$$\text{Regulation} = \frac{\sqrt{(100 + PIR + WIX)^2 + (IX)^2} - 100}{E}$$

where (100 + PIR + IX) is the voltage in phase and IX is quadrature voltage.

P = power factor = 100 with non-inductive load.

IR = primary + secondary drop in per cent.

W = magnetizing current in per cent of full load current.

IX = reactive drop in per cent.

The values affected in this formula are those of magnetizing current, and reactive drop, resistance remaining constant at all frequencies, and since WIX is only a small fraction of one per cent, we are safe in saying that the change in regulation of a transformer operating at sixty to thirty cycles will hardly exceed in well designed transformers more than 0.1 per cent.

The above discussion leads us then to the following conclusions:

A lowering of frequencies from sixty to forty cycles will increase our core loss 18.6 per cent. A lowering from sixty to thirty cycles will increase it thirty-four per cent.

Transformer capacity will decrease in

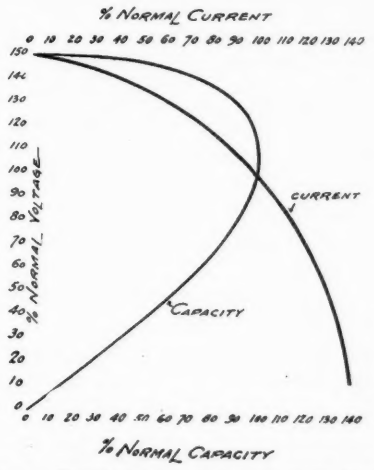


Fig. 3.—Variation of Capacity with Voltage—Sum of Core and Copper Losses Constant.

the first instance to 92.5 per cent normal capacity; in the second to eighty-six per cent. In the case of large station transformers (oil immersed) where the iron loss is about twice that of copper loss, the capacity with a change from sixty to thirty cycles will be cut in half. With air-blast transformers the capacity may be left unchanged when operated on a lower frequency provided the irons can be cooled effectively to keep them at normal temperatures.

The exciting current will rise with the falling off of frequency at about the same rate as the hysteresis loss. Regulation is affected but slightly, the lowering of the frequency causing better regulation, but within fifty per cent variation of frequency the difference will not exceed 0.1 per cent.

CHARACTERISTICS AT VARIABLE VOLTAGE.

We have seen how transformers would operate at a frequency different from the one they are intended for, and we shall now investigate as to the effect of variable voltage on the same apparatus.

Transformers when used at voltages lower than normal will have the benefit of a lower iron loss. It will be unsafe, however, to increase beyond a certain limit the ampere capacity of the transformer to compensate for the gain in core loss, as the excessive current density in the copper may result in an abnormal rise of temperature in the winding, though the combined iron and copper loss is kept constant. The table given below is compiled on the assumption of a constant total loss and whatever gain was derived from a lower operating voltage was taken advantage of by allowing a larger load current. The capacity of the transformer was also calculated, but on purely kilovolt-ampere basis, without any allowance made for proper correction as to temperatures. It was assumed in this computation that the iron and copper losses are equal at normal voltage.

Per Cent. Normal Voltage.	Per Cent. Normal Core Loss.	Per Cent. Gain Core Loss.	Per Cent. Normal Current.	Per Cent. Capacity K. V. A.
10	2.5	97.5	140.5	14.05
25	10.9	89.1	137.5	34.4
50	33.0	67.0	129.2	64.6
75	63.0	37.0	117.0	87.75
100	100.0	0.0	100.0	100.0
125	149.0	49.0	71.4	89.5
150	191.0	91.0	3.0	4.5

The figures and the accompanying curves show the capacity greatly decreased when the voltage differs from normal. With an increase of voltage fifty per cent the core loss amounts to 95.5 per cent of the combined copper and iron losses and when the transformer operates at ten per cent normal voltage the copper loss is equal to 70.25 per cent of the combined losses. In both instances the capacity in kilovolt-ampere is greatly reduced.

CORE LOSS.

We shall refer once more to our fundamental formula

$$\frac{E = \sqrt{2} \times 3.14 \times TNAB}{10^8}$$ where T, N and A are constant values, hence calling $$\frac{\sqrt{2} \times 3.14 \times TNA = k}{10^8}$$ we get $E = k B$,

or at constant frequency the magnetic induction varies directly as the voltage, and since the hysteresis varies directly with 1.6 the power of induction while the eddy current varies directly as the square of induction, the core loss will vary as some value between 1.6 and 1 of the induction, depending on the frequency at which these transformers are operating.

Let us consider the frequency of sixty cycles and find the multiplier expressing the relation between volts and induction.

From the table of constants of conversion of hysteresis and eddy currents, we find that the eddy current loss constitutes thirty-eight per cent of normal core loss. Hysteresis, sixty-two per cent of iron loss, varying as 1.6 power of induction and eddy current thirty-eight per cent of iron loss varying as the square of induction.

An increase in, say, ten per cent above normal voltage will cause a corresponding increase in induction. The hysteresis loss will rise by $(1.1)^{1.6}$; $(1.1)^2$; while eddy current loss will rise by $(1.1)^2$.

Reducing the expression to a simpler form we find the hysteresis equal to 1.165 of the normal loss of sixty-two per cent and the eddy current equal to 1.21 of the normal loss of thirty-eight per cent or ex-

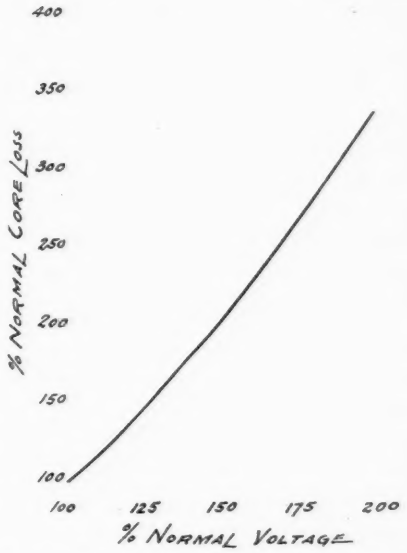


Fig. 4.—Variation of Core Loss with Voltage Above Normal.

pressing it in times of core loss it will be 1.182 times the normal core loss.

The higher iron loss will reduce the current of the transformer for the same kilovolt-ampere capacity, making the current 90.9 per cent of the normal current and reducing the copper loss to 82.6 per cent of normal loss.

So we find an increased iron loss of 18.2 per cent to be accompanied by a decrease in copper loss equivalent to 17.4 per cent. The iron loss being larger than the gain in copper loss by 0.8 per cent, the all-day as well as full-load efficiency will be somewhat less.

An increase in twenty per cent above normal voltage will affect the transformer as follows:

Hysteresis will increase 34 per cent.

Eddy current will increase 44 per cent, and the combined loss will increase 37.8 per cent. For the same kilovolt-ampere the current in the coils will be only 83.3 per cent of normal and the gain

in copper loss resulting from same will be 30.6 per cent. The excess of the increased iron loss over the gain in copper loss amounts to 7.2 per cent, which makes the increase in voltage of twenty per cent prohibitive. Besides the question of excessive core loss, the excessive exciting current will enter in consideration as well, as the diminished factor of safety in the insulating material will have to be contended with.

A decrease in ten per cent of normal frequency will give us the following per cent of gain and loss:

Core loss will be decreased to $0.90^{1.6} = 84.5$ per cent normal hysteresis, $0.90^2 = 81$ per cent normal eddy loss.

The combined iron loss amounting to 83.1 per cent normal core loss, or a gain of 16.9 per cent, and the copper loss increasing 21 per cent. This condition is not as favorable as an increase in voltage by the same amount. Thus we see that a change of ten per cent above the voltage the transformers are designed for will allow satisfactory operation and increase the total loss by 0.8 per cent affecting the result as to the efficiency of either the transformers or the plant but very slightly, while a higher change in voltage will affect the efficiency of the apparatus as well as its rating to a considerable degree. Taking the same guaranteed losses as those discussed under the heading of the affect of variable frequency and correcting same by the factors given above we get the following losses:

CORE LOSS.

Normal conditions, losses as guaranteed. 60 cycles — 2,080 — 104-208 volts.

K. W.	Core Loss in Watts.	Copper Loss in Watts.	Total Loss.
1.0	39	27	66
3.0	62	65	127
5.0	95	94	189
7.5	117	125	242
10.0	156	147	303
15.0	202	215	417
20.0	232	290	522
25.0	258	327	585
30.0	302	394	696
Computed losses. Voltage 10 per cent above normal.			
1.0	46	22.5	68.5
3.0	73	54.0	127.0
5.0	112	78.0	190.0
7.5	138	103.0	241.0
10.0	184	121.5	305.5
15.0	238	177.5	415.0
20.0	274	239.0	513.0
25.0	305	270.0	575.0
30.0	355	325.0	680.0
Voltage 10 per cent below normal.			
1.0	32.5	33	65.5
3.0	51.5	79	130.5
5.0	79.0	114	193.0
7.5	97.0	153	250.0
10.0	130.0	178	308.0
15.0	168.0	260	428.0
20.0	193.0	351	544.0
25.0	214.0	396	610.0
30.0	251.0	477	728.0
Voltage 20 per cent above normal.			
1.0	4.0	19	73.0
3.0	85.5	45	130.5
5.0	131.0	65	196.5
7.5	161.0	87	248.0
10.0	215.0	102	317.0
15.0	278.0	149	427.0
20.0	320.0	201	521.0
25.0	356.0	227	583.0
30.0	417.0	274	691.0
Voltage 30 per cent above normal.			
1.0	62.0	16.0	78.0
3.0	98.0	35.5	133.5
5.0	150.0	55.5	205.5
7.5	185.5	74.0	259.5
10.0	247.0	87.0	334.0
15.0	320.0	127.0	447.0
20.0	368.0	171.0	519.0
25.0	409.0	193.0	602.0
30.0	479.0	232.0	711.0
Voltage 50 per cent above normal.			
1.0	79.5	12.0	91.5
3.0	127.0	29.0	156.0
5.0	194.0	42.0	236.0
7.5	239.0	55.5	294.5
10.0	318.0	65.0	383.0
15.0	412.0	95.0	507.0
20.0	473.0	129.0	602.0
25.0	526.0	145.0	771.0
30.0	616.0	175.0	
Voltage 100 per cent above normal.			
1.0	133	7.0	140.0
3.0	210	16.0	226.0
5.0	325	23.5	348.5
7.5	400	31.0	431.0
10.0	530	37.0	567.0
15.0	686	54.0	740.0
20.0	790	72.5	862.0
25.0	877	81.5	958.5
30.0	1030	98.5	1128.5

While small standard transformers may be easily put on a circuit of double voltage, the apparatus in larger sizes is often designed at considerably higher induction, and double voltage impressed on the transformer will even with the transformer secondary open circuited take a considerable load, the iron being pretty well magnetically saturated.

The difficulty of dealing with saturated iron on over-potential test becomes very pronounced when manufacturers undertake to build apparatus which they guarantee to withstand a triple potential across the transformer coils.

At an acceptance test witnessed by the writer, the manufacturer, endeavoring to demonstrate the safety of the apparatus at triple normal voltage, resorted to a high frequency machine, which was a 133-cycle machine speeded up to 165 cycles, and then succeeded in impressing only double voltage. The high speed of the alternator caused an excessive armature reaction and the demagnetized alternator field would not generate a voltage high enough for the test.

The transformers were of the air-blast type, 1,100 kilowatts, the high frequency alternator running at 165 cycles, and while reducing greatly the hysteresis loss increased the eddy current loss on account of the increased frequency.

Let us get at the actual figures in this particular instance. The transformer, as stated, was to operate at sixty cycles. Core loss at normal voltage was equal to 11,000 watts. If sixty-two per cent of this loss is hysteresis and thirty-eight per cent eddy current, the iron losses will be 6,820 and 4,180 watts respectively. With an increase of frequency to 180 and a rise in voltage to three times normal, the hysteresis loss will come to 22,700 watts, as against the original hysteresis loss of 6,820 watts. And the eddy current loss at same potential will be 37,200 watts, as against 4,180 watts. Total loss in the iron amounting to 59,900 watts.

This example is made mention of as an extreme case to illustrate more vividly the behavior of transformers at a voltage much in excess of normal voltage.

EXCITING CURRENT.

With increased voltage there will be an increased exciting current in consequence of a proportionally larger induction.

$$\text{Exciting current} = 1.41\ K\ \frac{B^{1.6}}{E}$$

Since B varies directly as E any increase in voltage will increase the exciting current. With a constant frequency this increased current will be smaller for the same change as expressed in per cent, when compared with the increase at variable frequency and constant voltage.

For instance, a change in voltage of twenty per cent above normal will increase the exciting current, making it

$$K\ \frac{(1.2\,B)^{1.6}}{1.2\,E} = K\ \frac{B^{1.6}}{E} \times \frac{1.2^{1.6}}{1.2} = 1.11 \times K\ \frac{B^{1.6}}{E}$$

or an increase of eleven per cent, while a change in frequency amounting to twenty per cent will affect the exciting current by as follows:

$K \times 80\,\% N \times (1.25\ B)^{1.6} = 1.14\ KNB^{1.6}$; an increase of fourteen per cent.

REGULATION.

A voltage different from that of normal not to be detrimental to the operation of synchronous and induction motors must not exceed much that of normal voltage. We shall therefore confine ourselves to a change of ten and twenty per cent and see how this would affect regulation for both non-inductive and inductive load. Wherever there is a motor load a reduction in voltage would not be advisable.

$$\frac{\sqrt{(100 + PIR + IX)^2 \times (IX)^2 - 100}}{E}$$

Non-inductive load, voltage ten per cent above normal.

An increase in voltage ten per cent will

decrease the current to ninety. Nine per cent normal IX will decrease to 90.9 per cent and WIX = 100.8 per cent.

Hence

Regulation will be improved.

INDUCTIVE LOAD.

$$\text{Regulation} = \frac{\sqrt{(100 + \text{PIR} + \text{WIX})^2 + (\text{PIX} - \text{WIR})^2} - 100}{\text{E}}$$

An examination of this formula will show at a glance, applying the correcting factors to the various quantities, that the regulation will be improved by raising the voltage ten or twenty per cent.

TO RECAPITULATE.

A higher voltage amounting to ten or twenty per cent will not affect the losses materially except that the increased core loss will reduce the all-day efficiency of the transformers. This difference in the instance of ten per cent rise will amount to 0.8 per cent and at twenty per cent rise higher losses will result in abnormal heating on account of high core loss and danger of breakdown, due to higher voltage.

A lowering of ten per cent will result in an increased all-day efficiency, but will reduce the full load loss efficiency as well as cause the transformer to run hotter.

The exciting current will increase with increased voltage, thus making the no-load current feeding the transformers larger. The regulation at either non-inductive or inductive load will be improved.

AUTOMATIC SYNCHRONIZING OF GENERATORS AND ROTARIES.[1]

BY PAUL MACGAHAN.

A successful automatic synchronizer should fulfil the following conditions:

(1) It should be certain and safe in its operation.

(2) It should take advantage of the first favorable opportunity for coupling.

(3) It should couple the machines as soon as the difference in speeds is reduced to a safe amount.

(4) It should close the contact in advance of the period of coincidence a sufficient amount for the switch to act, thus coupling the machines at the exact point of synchronism. The greater the difference in speed, the greater should be this advance in angle, in order to make the time allowed constant. As different kinds of switches require different lengths of time to close, the amount of advance should be adjustable.

(5) It should prevent the coupling taking place if the speed of the incoming machine differs too much.

(6) If anything in the mechanism fails, it should prevent the coupling.

(7) It should not close the contact when the machines differ seriously in their voltage, even though in phase. A difference in voltage of twenty-five per cent may cause a serious interchange of current between the machines; a difference of phase of fifteen degrees will generally cause more.

A new device has been perfected recently by the Westinghouse Electric and Manufacturing Company, which seems to fulfil all the seven conditions above enumerated in a highly satisfactory manner. This new synchronizer consists of a pair of solenoids, each actuating a laminated iron core, supported from opposite ends of a rocker arm. Each solenoid is wound in eight separate sections, alternate sections being connected in series, thus forming two circuits in each solenoid; one circuit of each solenoid is connected in series with a circuit of the other solenoid, thus forming two independent circuits in the instrument, each circuit having half of its turns on each solenoid: one circuit is connected to a pair of binding posts deriving current from the bus-bars, and the other circuit to binding posts connected to the incoming machine. The connections of the various sections are so made that when the incoming machine is in phase with the bus-bars, the currents in one solenoid act in conjunction, thus pulling down the core, and the currents in the other solenoid neutralize or cancel each other magnetically, and produce no pull. On the other hand, when the machine is in opposition to the bus-bars, the currents in the first solenoid neutralize, and the second solenoid exerts a pull, its currents acting in conjunction.

The cores are suspended so as to reach the magnetic neutral of the coils at their extreme down stroke; thus, when the machines differ in speed, the horizontal beam rocks to and fro, with a harmonic motion. As the incoming machine approaches the frequency of the bus-bars, the motion becomes slower, and finally ceases when the machines are at the same frequency; if the machines are in phase the first core will stop at its lowest position, unless the voltages differ considerably, when the currents will not neutralize, and the core will not be able to reach its extreme stroke. One end of the rocker arm carries a contact spring which slides along the top of a fibre segment. This segment has a platinum strip on the top, which in conjunction with a stationary spring forms the contacts of the relay circuit. The springs and contact are of such length that when the segment is stationary contact can only be made when the first core has reached its extreme position.

When the left end of the rocker arm rises, it tends to lift the piston of a dash-pot, and elongate the spring. Upon the return stroke a valve in the dash-pot opens, allowing a quick return motion.

The piston rod of the dash-pot carries an arm, which is so attached to the contact segment as to shift the latter to the left, thus advancing the position of the contact when the rocker arm moves up with a sufficient speed to draw up the dash-pot piston. The slower the motion of the rocker arm, the less the piston of the dash-pot is raised, and consequently, the less the contact segment is advanced. The action of the synchronizer is as follows: as the voltage of the incoming machine builds up and it approaches the approximate frequency of the bus-bars, the rocker arm oscillates violently, the dash-pot piston advancing the contact segment so far that no contact is possible, no contact being possible on the return stroke. As the speed of the incoming machine increases, the rocking becomes slower, and the dash-pot piston advances the contact segment less, until finally the right contact spring no longer drops away from the contact, and as the right-hand core descends a contact spring on the left advances to meet the contact, thus energizing the auxiliary relay, which operates the switch-closing circuit just sufficiently ahead of the point of coincidence of the phases, so that actual coupling takes place at the exact instant of synchronism. If the machine approaches the point of synchronism more slowly, there is less advance of the contact segment, and the actual time allowed for the switch to act is the same as before. In the extreme condition, when the machine is coming in very slowly, there is no appreciable advance of the contact segment, the dash-pot having time to exhaust. The amount of the advance of the segment can be adjusted to suit switches having different times of closing, by varying the tension of the spring attached to the dash-pot piston.

[1] Abstract of paper presented at the convention of the National Electric Light Association at Denver, Col., June 6-9, 1905.

ELECTRICITY IN THE CHEMICAL LABORATORY.

BY HOWARD S. KNOWLTON.

One of the most interesting features of electrical work is the ease with which current may be utilized by industries and business activities that have no relation or resemblance one to the other. Thus, electricity operates a candy-pulling machine or a surgical lamp just as well as it carries half a million people into a city in the morning and home again at night; and it drives a cotton mill with the same facility that it carries the peculiar personal qualities of the human voice across hundreds of miles of prairie, cañon and divide. In making a study of modern industry it is difficult to find any sphere of human endeavor which has not been directly or indirectly benefited by electrical progress.

Applications of electricity on a vast scale are constantly being exploited, but, while this is going on, advances are also being made in many arts and sciences beyond the ordinary run of public familiarity. Prominent among the increasing users of electricity as a convenience in scientific work stands the modern chemical laboratory. Few outside the ranks of progressive chemists appreciate the extent to which electrical methods are applicable in analytical or synthetic investigations.

It is safe to say that the field of electrochemistry, looked at from either the purely scientific or the business standpoint, offers to-day a unique opportunity to the specialist who would practise in a department comparatively untrammeled by past research, and almost unlimited in its possibilities. With the electric furnace and the electrolytic bath as instruments of attack, it would be idle to set a boundary to the probable achievements of the next decade or two. The path of the investigator and the chemical engineer bristles with unsolved problems, from the discovery of improved methods of storing electricity to the direct production of commercial current from fuel. As time goes on the steadily increasing value of coal is bound to exert a more and more powerful influence to secure greater efficiency in the generation of electrical energy. To the electrochemist, more than to any other man of science, the world looks for at least the partial solution of such vital problems.

In the modern chemical laboratory few of the conditions which surround experiments and tests are small enough to be neglected. The accomplishment of accurate work demands not only delicate balances and pure reagents—it requires the hygienic surroundings of the incandescent lamp and the ventilating fan, if such work is to be prosecuted with a minimum of physical wear and tear. Gas may be a useful commodity in a Bunsen burner or in a fish-tail flame for bending glass tubes, but it has little place as an illuminant in the ideal chemical laboratory. It was not enough to ventilate a lecture room by the hoods and wall ducts of older days. The latest practice now installs a ventilating duct in the lecture table itself, through which fumes and gases are exhausted by a motor-driven fan of a quarter horse-power or thereabouts, mounted in the basement or some other convenient place. In the new chemical lecture room of Simmons College, Boston, an arrangement of this sort enables lectures on chlorine gas and other powerful irritants to be carried on without the least discomfort to the students and practically none to the instructing staff. The various water-bottles, tubes, generators, etc., are set upon the table within an area directly tributary to the ventilating duct.

Microscopic work belongs more to the physicist perhaps than to the chemist, but it is frequently desirable to examine a newly formed compound under the lens in the latter's experiments. Small electric lamps are now made for exactly this work, an absorption screen being provided to take care of the excess of yellow rays. When ordinary sixteen-candle-power lamps are employed for this work the convenience of a flexible suspension is immediately demonstrated. A handy electric lamp operated by a small battery is also on the market for use in the photographic dark room. Substituted for the greasy and odorous candle in the ruby or orange lantern it gives a clean, easily regulated light at a cost of about a cent an hour, with absolutely no fire risk to contend with. In the chemical storeroom the greater safety of the electric light as compared with older illuminants immediately commends itself.

Storage batteries now constitute a valuable part of modern chemical laboratory equipment, especially where currents of high amperage are desired in experiments. In tests requiring considerable heat extending over a long time the storage battery affords a steadiness of current that exceeds the ordinary electric service supply, although both direct and alternating circuits are brought to appropriate terminals in the latest laboratories. Especially valuable is the electric current when used in heaters to raise the temperature of inflammable and highly volatile liquids—a process never accomplished without the gravest danger of fire or explosion when gas is employed. Even the steam bath is less easily controlled and the heat less concentrated than in the electric heater.

An interesting application of electricity is the operation of stirring devices by small motors. In the case of one laboratory which makes a specialty of determining the heating value of coal, the chemist in charge has fitted up two motors of practically toy size to drive stirring propellers in the water-jackets of his bomb calorimeter. The motors were built by a jeweler, and so smoothly do they run that the former burdensome work of stirring the water is now entirely transferred from human hands, leaving the investigator free to devote his attention to the exacting details of temperature observation. Through the use of electricity it has been possible to determine the temperature correction necessary to apply to eliminate the error due to the heating of the water in the jackets by the stirring blades. The ignition of explosive mixtures by the electric spark or by the incandescent wire has long been familiar to laboratory workers.

The quantitative decomposition of water, hydrochloric acid and other liquids or solutions is effected and controlled with the greatest ease by electrical means. In like manner the electroplating of metal constitutes a useful application in the laboratory and a field of absorbing interest for advanced scientific study.

For driving small lathes, grinders, coal crushers and other tools which are of use in the larger-scale operations of the chemical laboratory, the electric motor has no superior. In this field it but extends its usefulness beyond the already numerous applications in general manufacturing establishments.

It is emphatically worth while for the chemist who is on the lookout for labor-saving apparatus to consider what electricity can do for him in the laboratory. The central station man, too, has an interest in extending the use of the commodity which he sells. That the future holds in store still greater usefulness for electricity in this field no one can doubt who looks into modern laboratory practice.

ELECTRICAL MINING NOTES.

THE MEETING OF THE BRITISH INSTITUTE OF MINING ENGINEERS.

BY SYDNEY F. WALKER.

The interest in electricity at the Mining Institute is well maintained. At the recent meeting in London there were two papers directly devoted to electricity; one in which electrical apparatus is interested, because the apparatus described in the paper forms a valuable adjunct to another that is driven by electricity, and because it is itself driven by electricity. There were two in which electrical engineers were interested, one because it detailed the best that steam can do as against electricity, and the other because it dealt with one of the means of generating electricity cheaply. The two purely electrical papers were upon winding by electricity. The author of the paper read some time since at the Mining Institute on the Siemens-Ilgner system of winding, gives a short résumé of work that has been done at a colliery in Germany. The shaft is 617 feet deep, the net load to be raised a little over 3,000 pounds per wind, the maximum power taken at the end of the acceleration period 305 horse-power, and the minimum ninety-five horse-power. With fifty-five windings per hour with the above load in two mine trucks, and with sixty-three windings per hour with a smaller load, the power consumption was 1.55 kilowatt-hours per wind. The efficiency of the whole apparatus between the actual work done in raising coal and the power delivered at the terminals of the motor-generator which delivers the current to the motors driving the winding drums was 44.5 per cent. The speed variation of the motor-generator flywheel was stated never to exceed seven per cent, and the whole worked with the greatest ease.

One of the non-electrical papers afforded an opportunity for comparing the cost of winding electrically and by steam on the latest lines. The paper in question described a compound-condensing winding engine that had been recently erected at an iron mine. The depth of the mine in this case was 590 feet, the net load about 7,400 pounds, and the coal used per actual horse-power expended in raising the ore, that is to say the net-work, was 6.9 pounds. To this cost has to be added all the costs of generating steam other than the cost of coal, together with the interest on plant, cost of repairs, etc., while against the cost of winding by the Siemens-Ilgner system must be put the interest and repairs bill of that plant. The result would show apparently, however, that for depths such as those at the German colliery where it was tried, the Siemens-Ilgner system is cheaper than steam. It is interesting to note that the coal expended per horse-power in raising the ore had been reduced from 14.2 pounds per horse-power with a depth of 400 feet without compounding and without condensing to the figure given above by compounding and condensing. The author of the paper remarked, however, that not much advantage was obtained by condensing, as the condenser was arranged to deal with a power station in addition to the steam plant for the winding engine, and the power station was not yet complete. This is rather an interesting point. It is often supposed that condensing must be economical under all circumstances, while it is forgotten that condensing requires output of power as well as the other plant, and that it often costs money for water. Apart from the cost of water, unless condensation brings a greater economy of coal than it demands for running its air and circulating pumps, it is not economical and the station would be better without it.

The other paper on electrical winding was a translation from a description of the apparatus shown at an exhibition in the great coal field in the north of France, the apparatus consisting of models of electrical winding apparatus in use in certain French collieries. Three apparatus were described, in one of which the flywheel used with the Siemens-Ilgner system is also employed, but in place of the arrangement for regulating the speed adopted in that system, a modification, which is also employed in another system, is employed. Two motors are used for the winding drums, running in series, just as tram-motors do, from the service, and the generator of the motor-generator develops a pressure equal to that of the service which is arranged to be opposed to or added to the primary pressure, so that the primary pressure being 500 volts the pressure at the terminals of the motors ranges from 0 to 1,000 volts, the speed of winding being controlled in this way. In the second colliery at which this method of regulating the speed is in use, the Lievin, there is no method of absorbing the power given up by the descending cage during the later portion of the wind.

In the third colliery, the Lens, there is no flywheel and only the usual resistance method of controlling the speed. The current is taken to the winding engine house at 5,000 volts, three-phase, transformed down to 200 volts and used at that in one motor. At this colliery the generators were driven by gas engines worked by producer gas made from the slack coal at the colliery, this method having been chosen after careful consideration in preference to using the waste heat from the coke ovens. This fact is of considerable interest here because the next paper was one dealing with the firing of boilers by the waste heat from coke oven gases.

Coke is made very largely in all parts of the colliery districts of the United Kingdom for use in iron-smelting. In Durham, where the coke has a very good name, at some collieries the whole of the output is made into coke. Usually, however, the small coal is washed and made into coke, the process consisting of heating up a mass of small coal and thereby driving off the volatile matter, leaving the fixed carbon behind. The volatile matter consists largely of combustible gases. There is always a considerable proportion of marsh gas and of hydrogen, the calorific power of these being respectively 53,000 and 62,000 British thermal units per pound as against carbon 14,000. Ordinary domestic illuminating gas has a calorific power of from 600 to 650 British thermal units per cubic foot, while some of the gases from the coke ovens in Yorkshire have been estimated at 460, and those at Whitwood, which have been referred to in former notes, have a calorific value of 550. The calorific value of the gases used by the author of the paper was not given, but it would probably be high. The results were given in the form of pounds of water evaporated per pound of coal coked, the highest being with Babcock boilers and what are called retort ovens, 1.78 pounds of water evaporated from and at 212 degrees Fahrenheit. The smallest was with a Lancashire boiler of the usual two-flued type connected to retort ovens, 0.349 pound of water per pound of coal coked. Babcock & Wilcox boilers connected to beehive coke ovens gave 1.069 pounds of water evaporated from and at 212 degrees Fahrenheit per pound of coal coked.

Coke ovens are broadly of two varieties. The old type, of which the beehive is a good sample, in which the heat necessary for driving off the gases is obtained by the combustion of a part of the coal itself in the oven, and the latter type, called the retort oven, in which the gases are burned in flues surrounding the ovens.

The surplus heat from the gases may be used in two ways: the gases may be

allowed to circulate through the oven flues, and then through the boiler flues. This is the method adopted by the author of the paper. Or a portion of the gases may be used for the oven flues, and the remainder after being scrubbed and purified may be burned either in the boiler furnace or in a gas engine. The rather striking fact brought out by the paper is, allowing for a delivery of 10,000 cubic feet of gas per ton of coal, which is what the gas companies obtain and allowing for the heat that is required for carbonizing the coke, the author of the paper obtained as high a result as could be expected, even if the gases had been scrubbed and used in gas engines. In fact, it is very doubtful, indeed, if the supposed economies claimed by certain professors by burning the coal in the form of gas in gas engines would be realized.

In connection with the electric winding papers, it should be mentioned that in the discussion one member, who is also a member of an electrical firm which does a large business in mining work, expressed the opinion that electrical winding would not be economical for plants requiring above 1,000 horse-power as a maximum at the end of the acceleration period. He gave an instance of a colliery requiring to raise 2,500 tons a day from two shafts, each 730 yards deep. He made the power required at the maximum acceleration 5,500 horse-power, and the plant required two 1,300-kilowatt generators and a motor-generator set capable of working up to 5,000 kilowatts and the cost of the plant £48,000, while that for steam-winding was only £12,000, and the saving per annum only £1,250 by the adoption of electric winding.

The other paper mentioned was upon a coal conveyer for use in conjunction with coal-cutting machines at the face of the coal. It has been worked out by two mining engineers, one in England and the other in America, the apparatus being adapted for the somewhat different requirements of the two countries. The coal-cutting machine, as has been explained in previous notes, undercuts the coal so as to allow it to leave the strata to which it adheres above and be broken up and filled into the mine wagons which take it to the surface. After it has been undercut or holed, as it is termed, holes are drilled in the upper portion of the coal and shots fired bringing down the coal in pieces and it is then filled into the mine wagons. Coal-cutting machines are most useful where the seams are very thin, eighteen inches to thirty inches, and it is there that the greatest difficulty in filling arises, as it adds to the cost very considerably; prohibitively in some cases, if the over or underlying strata are removed to make head-room. Working in a space thirty inches or even thirty-six inches high is not convenient, and filling into mine wagons and getting the wagons away is a difficult process. The new conveyer, which has been worked out by Mr. Blackett in England and Mr. Claghorn in America, solves the problem by taking the coal from the face to a gate-road, as it is called, at the end of the coal face, where there is more room and there loading it into waiting tubs. The conveyer consists of a chain specially arranged to carry lumps of coal running in shallow iron troughs, the return chain running under the troughs, and the whole being mounted upon iron trestles. The fillers simply place the lumps of coal on the conveyer which is always close to them wherever they are and it is carried away to the mine wagon waiting for it. A conveyer chain is run either by an electric motor or a compressed-air engine. The gearing is either spur or worm, the conveyer requiring ten horse-power with the latter, and from six to eight horse-power with the former. The interest for electrical engineers lies in the fact that once electric currents are delivered at the face, the whole of the work is done with them. The coal is undercut by an electrically driven machine, it is drilled for the shots by an electric drill and it is conveyed to the gate-road by an electrically driven conveyer and probably conveyed from the shaft bottom by an electrically driven haulage system.

New York State Electrical Contractors' Convention.

The semi-annual convention of the Electrical Contractors' Association of New York State was held at Rochester on June 15. The sessions were held in the assembly hall of the Chamber of Commerce. Preceeding the business meeting, a meeting of the board of directors was held. President Marshall L. Barnes, of Troy, presided at the sessions. In the afternoon excursions were held to a number of electrical plants and points of interest about the city, and a party of about fifty made a trip to Ontario Beach on Lake Ontario, and took dinner at the Hotel Ontario.

The association is composed of about 100 members and has branches in various cities in the state. Among the officers and delegates at the convention were:

President, Marshall L. Barnes, Troy; vice-president, James P. Strong, New York; treasurer, Julius C. Stearns, Buffalo; secretary, Fred Fish, Rochester; director of New York branch, James A. Strong; director of Rochester branch, Morris J. Olmstead; director of Buffalo branch, Julius C. Stearns; director of Syracuse branch, James Hilton; director of eastern branch, Frank L. Frost; secretary of the national association, W. H. Morton, Utica.

Delegates, C. A. Georgia, Elmira; M. S. Horton, Clarence Wheeler, Thomas H. Green, Rudolph Schmidt, E. C. Seitz, Philip Crapsey, Walter H. Toby, Rochester; H. J. Sackett, J. D. Robertson, A. D. McCarthy and J. J. O'Leary, Buffalo; G. H. Fowler, E. J. Richards, Poughkeepsie; A. J. Martin, Sol. Davis, James Blackhall, New York city; W. Covert Jones, Geneva; George Brayton, Utica; James Burns, Schenectady.

The Copper Market in May and June.

The following figures are from *Copper Gossip*, published by the National Conduit and Cable Company, New York city. They show the quotations for copper at New York and London on the dates given.

1905.	Lake. Cents per Pound.	Electrolytic. Cents per Pound	Cash Standard, London. £ per Long Ton.
May 18....	15⅛ @ 15¼	15	£65 0 0
May 25....	15 @ 15⅛	15	64 12 6
June 1....	15 @ 15⅛	15	65 7 6
June 8....	15 @ 15⅛	15	65 17 6
June 15....	15 @ 15⅛	15	65 17 6
COMPARISON WITH PRICES LAST YEAR.			
1904.			
May 18....	13¾ @ 13⅞	13 @ 13⅛	£57 0 0
May 25....	13 @ 13⅛	12⅞ @ 13	56 7 6
June 1....	13 @ 13⅛	12¾ @ 13	56 12 6
June 8....	12¾ @ 13	12⅝ @ 12¾	56 10 0
June 15....	12⅛ @ 12⅝	12⅜ @ 12½	56 2 6

The figures for exports and imports of copper during the first half of 1905 are given as follows:

Exports of copper for first half of June, 1905, amount to 9,986 tons, or at the rate of 19,972 tons for the whole month.

Exports for the entire month of June, 1904, were 16,279 tons.

The exports of copper to China and Japan since January 1 to June 1 amount to 27,875 tons.

Month.	Tons.
January	21,245
February	17,508
March	21,073
April	24,121
May	23,758
Total five months	107,705

Exports of copper first five months of 1904 were 97,765 tons.

IMPORTS OF COPPER, 1905.

Month.	Tons.
January	6,850
February	7,000
March	7,795
April	7,530
May (estimated)	7,000
Total five months	36,175

Imports of copper first five months of 1904 were 32,775 tons.

COMBINED TELEPHONY AND TELEGRAPHY.[1]

BY SAMUEL G. MCMEEN.

Perhaps the advantages of combined telephone and telegraph working on the same circuits can be shown more clearly in a picture than otherwise. Fig. 1 is intended to show what is at present possible in this direction. In this figure it will be seen that over a line of a single wire, using earth as a return, one telegraph and one telephone service may exist at the same time. Over a two-wire line, by one method of operation, one telegraph and one telephone service may be secured at the same time; and this may be accomplished in

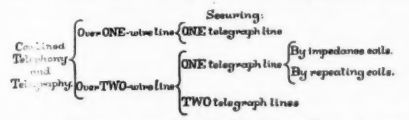


FIG. 1.—POSSIBILITIES OF COMBINED TELEPHONY AND TELEGRAPHY.

two different ways so far as the apparatus and principles are concerned.

By another method of working, a two-wire line may be made to furnish one telephone and two telegraph services at the same time. In all of these arrangements, under proper conditions, there is no interference between the two classes of service. The whole matter of superadding telegraph to telephone service on a one-wire

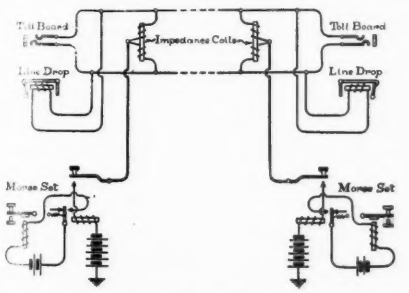


FIG. 2.—SINGLE TELEPHONE AND TELEGRAPH SERVICE OVER METALLIC CIRCUIT.

line, or the reverse, may be dismissed by saying that it is not yet shown to be possible to do both things over a single wire without reducing in some degree the quality of the telephone service; the principal commercial application of such a plan is to convert the existing grounded telegraph lines into combined ones, thus securing telephone service of some value, without serious interference with the simplicity and convenience of the telegraph service. This is accomplished by the introduction of certain rather delicate apparatus for signaling, of more than usually powerful transmitters, and of receivers of less than usual sensitiveness. A little thought will show that circuits specialized in this way can not be connected to the standard telephone systems of cities, so that this form of combined working must be considered special, though valuable.

Combined working over two-wire or

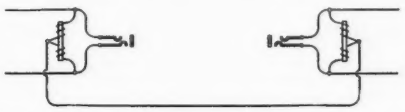


FIG. 3.—TELEGRAPH CIRCUIT CARRIED A GREATER DISTANCE THAN TELEPHONE CIRCUIT.

metallic circuit telephone lines, however, is free from this objection and, indeed, from any other very serious ones. I shall try to show what and how important are the limitations which may be expected.

Any metallic circuit telephone line which is good enough for quiet commercial telephone service, may be made to furnish one telegraph circuit by having impedance coils bridged across it, as shown in Fig. 2. These coils should contain turns enough to enable them to be bridged across the circuit with no greater reduction in telephone transmission than would be caused by bridging across a high impedance standard drop or ringer. The magnetic circuit may be open or closed; that is, the windings may be upon a straight bundle of iron wires, or upon a ring-shaped core. A tap is to be taken from the middle of the winding, or, which is equivalent, from the junction of two similar windings on the same core. This tap is carried to the telegraph apparatus and may be considered simply to be the end of the telegraph line. Any desired arrangement of telegraph apparatus may be added to the circuit thus secured, the only limitation being that the method of working should not involve high frequencies, such as are met in the Edison phonoplex or in any of the high-speed systems of automatic telegraphy.

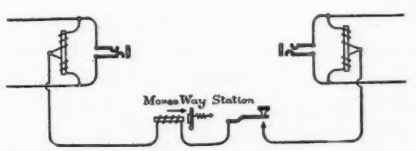


FIG. 4.—TELEGRAPH STATION INSERTED IN EXTENSION OF TELEPHONE CIRCUIT.

Should it be desired to build up a telegraph circuit longer than the available metallic circuit, or to carry the telegraph circuit over a route not already provided with a telephone circuit, the tap for the purpose may be taken from the telephone pair through an impedance coil and into another pair in a similar way. This arrangement is shown in Fig. 3.

If desired, a telegraph set may be inserted at such a point as this, where the telegraph line transfers from one pair to another. Fig. 4 shows this condition.

Should it be desired to insert a pay station in a telegraph circuit at a point which is not a terminus of a telephone circuit, condensers may be inserted in each of the wires, impedance coils bridged beside them, and the Morse apparatus inserted in the bridge wire which thus emerges from the pair. This arrangement is shown in Fig. 5.

In all the foregoing plans involving the use of impedance coils, there exists the difficulty that in case the two telephone lines so equipped are switched together through a toll-board having no condensers or repeating coils in its cord circuits, the two sets of Morse apparatus will be connected together and confusion may result, quite as does when two telegraph lines

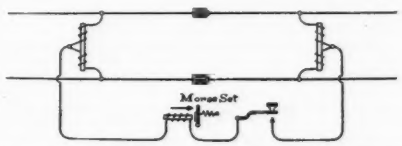


FIG. 5.—TELEPHONE PAY STATION INSERTED IN TELEGRAPH CIRCUIT.

become crossed. Inasmuch as condensers of two microfarads or greater capacity do not interfere with successful telephone transmission, cord circuits so equipped will be free from this fault. For the same reason the loop arrangement shown in Fig. 5 is free from any telephonic objection.

There is another fault in the impedance coil plan, in that ringing generators, suitable for local exchange line signaling, often require to have one terminal permanently grounded, or to have temporary grounds applied during the time signals are being rung upon party lines, grounded rural lines, or other circuits involving ground in any way. If the same source of ringing current is used for toll-line signaling, a little thought will show that the telegraph outfit will frequently be disturbed by a series of dots, caused by ringing current passing to ground through the Morse relays.

A preventive for such a derangement is found in providing separate ringing apparatus for toll operators, or by securing the ringing current for these operators through special transformers.

Roughly speaking, the best conditions of operation with the impedance coil plan

[1] A paper presented at the first annual convention of the National-Interstate Telephone Association at Chicago, Ill., June 21-22, 1905.

will be secured when, with a high resistance total Morse circuit, high-resistance telegraph relays are used. It is not required that the resistance of the impedance coils be great, but only that their inductance and consequent choking due to voice currents be great. This is an immediate result of the iron core and the turns. For an expedient, a ringer may be used as such a choke coil, its two terminals being bridged across the telephone line, and a telegraph tap taken by extending the junction between the wires of the two spools. Such an arrangement, if the spools are at all nearly equal, will be quite successful. If a number of circuits are so treated, the ringers of the different circuits must not be stored close together with their cores parallel, or cross-talk between the circuits may result. This may be prevented by placing the adjacent ringers with their cores at right angles to each other.

It is obvious that a high impedance tubular drop having a middle terminal may also be used for such a telegraph tap, and in such a case the danger of cross-talk disappears, being prevented by the shield.

If such high impedance devices as

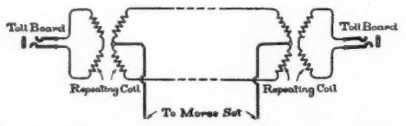


FIG. 6.—METHOD OF TAKING TAP FROM LINE SIDE OF REPEATING COIL.

ringers and drops are used for these taps, the Morse relays should be wound to high resistance, say 500 to 1,000 ohms.

By the use of repeating coils to be permanently inserted in the telephone line at the points where the telegraph tap is to be taken from the circuit, one Morse line may be secured from a two-wire circuit quite as has been described for the use of impedance coils. Fig. 6 illustrates how the tap is taken from the line side of the repeating coil. Coils may be secured in the market with arrangements made for taking out this tap. Connections to Morse apparatus are quite the same as are shown in Figs. 2 and 4. This arrangement has the advantage that no connections between telephone lines in the way of ordinary switching, nor any peculiarities of ringing apparatus, will affect the telegraph apparatus adversely. It has the disadvantage that the introduction of two repeating coils in a circuit causes a distinct loss in both voice and signal transmission, all the more marked when several lines so equipped are connected together. From the practical standpoint, this plan is not recommended for other than short lines, and then only under excellent conditions where freedom from interference is the thing most greatly to be desired.

The reason for non-interference between the telegraph and telephone services in either the impedance coil or repeating coil plan is that at any point where telephone apparatus connects to the two wires of the circuit, the potential difference of the two wires due to telegraph currents is always zero.

The arrangement of things shown in Fig. 7 is that which gives two telegraph circuits in addition to one telephone circuit from each pair of wires. The drawing shows the situation far more clearly than it can be described in words. The principle involved is that of different frequencies, the pulsations which make up the telegraph signals being so very much slower than those of the voice currents. When it is remembered that this drawing shows the equipment at one end of the line, and that the distant equipment is an exact duplicate; that the impedance coils *a a* are capable of passing telegraph impulses with little or no harmful effect upon them; that these coils further act with such a choking effect upon voice currents as to be practically opaque to them, and that the condensers of two motive forces each are relatively transparent to alternating currents and opaque to direct currents, it will be easy to see how the two systems of communication can go on at the same time.

A close examination of the drawing will show that the direction of windings in the coils *a a* is such that the two halves of the total winding are connected in the familiar differential or reverse relation to each other. It will also be noticed that this is not true of the coils *b b*. In the coils *a a*, therefore, so far as direct currents are concerned, the magnetizing effort of one winding of each complete unit neutralizes that of the other; and this is also true for direct currents, even if interrupted at the highest frequency used in telegraphic hand work; but for currents of such high frequency and small volume as those of speech, the windings of each unit are practically two independent choke coils in series.

While the other arrangements which have been discussed secure non-interference between the two systems of communication by preventing the telegraph from producing any effect at all in the telephone receivers, this plan operates to modify the telegraph signals in such a way that, although they affect the receivers, they do not produce audible sound. A careful examination of the diaphragm of a receiver properly connected across a composite line while the telegraph is working will show that it is moving through a considerable range, even though nothing whatever can be heard when the instrument is held to the ear.

I have indicated that each of the plans has some disadvantages. The flaw in this plan is that the shunt across the circuit through the coils and condensers is sufficient to prevent any ordinary ringing. Signals from one station to another require to be given over some Morse line, or by the assistance of special apparatus adapted to respond to currents of very high frequency. As the voice current is of a high frequency and can pass over the pair, so some other high frequency, but of larger volume, may be used to

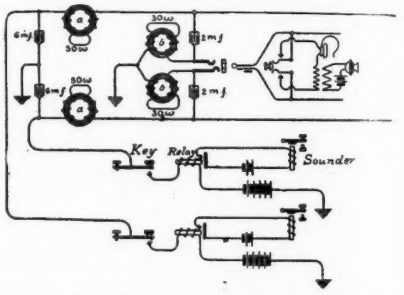


FIG. 7.—TWO TELEGRAPH CIRCUITS AND ONE TELEPHONE CIRCUIT FROM PAIR OF WIRES.

operate a relay at the distant station, and that in turn to display a signal. I have no plan to recommend, however, as there is no simple and convenient arrangement available.

The ordinary ringing current is of about sixteen cycles per second: a skilled telegraph operator will send thirty-two dots per second; the half waves of the ringing current are less abrupt in change than the telegraph dots. For these reasons it is apparent that one may send ringing current instead of telegraph current over any composite Morse line without interfering with the telephone. This possibility enables one to sell the service of one side and retain the other for ringing. The arrangement of keys and signals is obvious.

Telegraph circuits secured in any of these ways may be treated as may be desired within reason, in the way of extending by repeaters.

There are three reasons why it is commercially of advantage to apply these composite methods to some of the cir-

cuits operated by almost any long-distance organization.

One of them is to secure an additional earning from the property, because by the very nature of things the lines are practically out of use during a large part of each total day. It is not found difficult to secure an annual telegraph revenue equal to five per cent, on the total cost of the circuit, and this without establishing offices or maintaining a special organization to care for commercial messages.

There is more demand for telegraph service in its private line form than is being fulfilled by all the existing telegraph equipment. An active canvass of commercial interests in one's locality, and particularly of those having offices, factories and branch houses in different places, is certain to produce contracts, at a rate less than for other methods, which will supply the consumer with a better result than he is now securing.

The investment on the part of the telephone company per telegraph station varies with the different plans, but in all cases is only about as great as the cost of the line and equipment of a telephone subscriber located at a similar distance from the central office. This statement is meant to cover the complete equipment, including the telegraph apparatus required at the consumer's station.

The second reason is the advantage of ticket wires over which much or all communication between toll operators may take place. Naturally, this enables toll operators to prepare for one conversation over an important circuit, while another is going on. An intelligent use of such facilities will enable the carrying capacity of the more remunerative lines to be increased enough to defer the stringing of additional circuits.

The third reason is in the transaction of the official business of the telephone company. By its very nature such a company has its offices scattered about the country, and it is too often its tendency to overburden its own circuits with its official business during the day, while on certain routes there may be too few circuits to carry even the remunerative business of the public. It is inconvenient to force the official business into the less busy hours of the day. A very small investment in composite circuits, and a slight rearrangement of the company's organization, will enable an official to dictate telegrams which the stenographer herself, with a little knowledge of Morse, may place immediately upon the line. Such business may or may not be confirmed by mail. It is not essential that the operators be skilled to high speed, as training in accuracy only is sufficient, and even fifteen words per minute is a sufficient rate. Very fast operators reach sixty.

If it is not desired to extend the telegraph network over an entire system, official telegrams may be landed in important centres and transmitted by telephone to destination. Experience in this method of handling messages will show that errors are less frequent than might be expected.

BOOK REVIEW.

"Steam Pipes, Their Design and Construction." William H. Booth. New York. The Norman W. Henley Publishing Company. Cloth. 187 pages. 5¾ by 8¾ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $2.

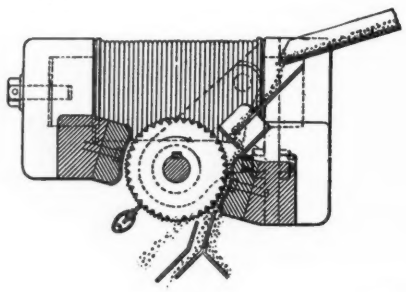
Mr. Booth is an English engineer who has done a great deal of writing for technical journals. He is also the author of a book on "Liquid Fuel and Combustion." In this book on steam pipes he has compiled a great deal of useful information and arranged it under convenient heads, as follows: flow of steam; materials; expansion; strength of pipes; pipe joints; pipe supports, directions of pipes, general arrangements; valves, drainage; junction pieces and flanges; separators, etc. In the chapter on flow of steam, formulæ of many different authorities are given for flow through orifices and through pipes, but the author has not always made it clear whether the formula is applicable to an orifice or a pipe and he gives no means of knowing which of the many formulæ are most reliable. The chapter on materials includes the subject of flanges, crosses, tees, etc., and many illustrations are given showing the usual English practice. We do not find any mention of the best modern American practice for flanges: that is the rolled or pressed steel flange. In the chapter on expansion, bent tubes are illustrated and a short table quoted from Mr. Stromeyer for the safe extensions of bends of six-inch pipe, but nothing is given to show how the safe extensions of the bends of any other diameter of pipe may be calculated. The chapter on general arrangements begins with the statement that "the general arrangement of a modern power station demands that the steam pipes enter into consideration as a prime factor and not as an afterthought." With this introduction we would expect to find a systematic treatment of the subject of laying out the steam pipes for a modern power station, with illustrations showing the arrangement, but instead of this we have a chapter only six pages in length without a single illustration and written in such a poor style that we doubt if any reader will get any benefit from it. A sample of the author's style is as follows: "should occasion demand it, each boiler main pipe may be connected across to the pipe of the next bank in order that an excess of superheaters need not be installed, but usually a well-managed station can be worked so as to enable the cleaning of a superheater to coincide with the cleaning of several boilers in one bank, and the virtual stoppage of the whole bank. This should be aimed at by providing rather a small amount of first-class plant than an excess of cheap trash." The chapter on valves contains the usual information which is found in manufacturers' catalogues. The same may be said of the chapters on drainage which include steam traps, junction pieces and flanges, and separators. The chapter on pipe coverings contains statements of the tests of pipe coverings which have appeared in different papers of the proceedings of the American Society of Mechanical Engineers. The book is closed with a five-page chapter on the kinetic theory of gases in its relation to the flow of steam. It closes with the following statement: "the theory is certainly an aid in the comprehension of the behavior of flowing steam and if clearly grasped it will help to explain why the efficiency of the heat engine is so small." It does not appear what this theory has to do with the subject of the book and it is not stated in such a way in this little chapter that it can be clearly grasped. Mr. Booth is an experienced writer and he could not write a book on any engineering subject which would not contain some valuable information; but it appears that this book is in the class called "pot boilers." It seems to have been thrown together hastily and it omits a great deal of the information which designers of power plants would like to have in printed form concerning the arrangements of steam piping and the best method of calculating diameters for particular purposes. We think Mr. Booth could have written a much better book if he had spent more time on the subject.

A New Radioactive Material.

In a brief account in the *American Journal of Science* for June, of late mineral researches in Llano County, Tex., which have been made by him, Mr. William E. Hidden mentions a peculiar formation which he encountered. He found unusually long radial lines projecting in many directions from the bodies of ore richest in thorium, uranium and zirconium. He called these occurrences stars, and sought for them as positive pointers to ore. Finally, on removing a seventy-pound mass of zirconium-yttrium-uranium and thorium ore, which was a nucleus to one of the best-marked of these stars, from its quartz matrix, his hands and face began to burn as if from the effect of strong sunlight, and after three days of this kind of mining a redness of skin and a burning sensation resulted which was followed by an actual soreness of the parts of his hands and face exposed to the direct emanations from the minerals. The author suggests that this burning be due to the work of a radioactive element of a peculiar, if not unique, kind.

Electrical Patents.

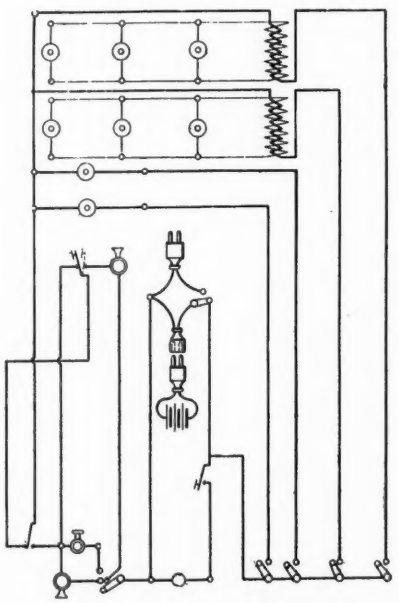
The International Separator Company of New Jersey is the assignee of a patent recently granted to Clarence Q. Payne, of Stamford, Ct., the invention relating more particularly to improvements in magnetic separators of the class described in letters-patent Nos. 641,147 and 641,220, granted to Mr. Payne on January 9,



Apparatus for Magnetic Separator.

1900 (791,494, June 6, 1905). The present improvements are more especially in the construction of the cylinder or separating carrier, being designed to increase the efficiency and simplify the structure of this carrier or cylinder. The improvements consist in an improved structure for obtaining "line dispersions" of the flux density in the magnetic field and also "point" and line dispersions thereof jointly, in the latter case without any accompanying decrease of the availing positions for the attachment of the ore particles undergoing separation, a further feature being that the surface of the carrier is so formed that the falling ore particles can not escape the point and line dispersion of the flux density. The invention comprises a transversely laminated separating cylinder composed of a plurality of magnetizable circular discs having teeth upon their edges, these discs being relatively so placed that the teeth of the adjacent discs are out of alignment. Two opposing pole-pieces are placed approximately concentric with said cylinder and the cylinder is arranged to move between these two pieces. A guide plate is connected with one of the pole-pieces and extends above the horizontal diameter of the cylinder.

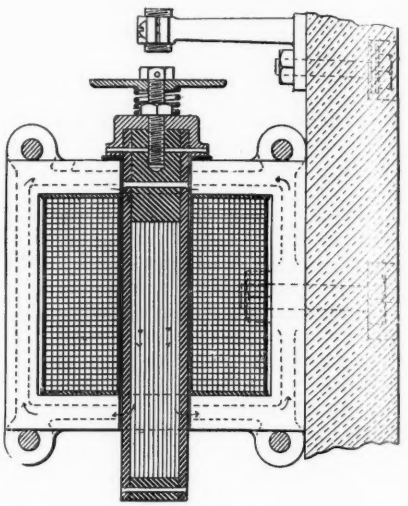
Herman G. Pape, of New York, N. Y., has secured a patent on an audiphone instruction apparatus or set, which is especially designed for the instruction of persons having impaired hearing (791,573, June 6, 1905). The object of the invention is to provide a simple and effective apparatus or set which includes one or more earpieces for a pupil or pupils, a teachers' receiver (corresponding in function to a telephone-transmitter), a pupil's receiver, and suitable electrical connections and circuit-closers whereby a pupil may connect the pupil's receiver to the earpiece when it is desired to practice articulation and whereby the teacher may cut out the pupil's receiver and simultaneously connect the teacher's receiver to the earpiece when it is desired to talk to the pupil. A further object of the invention is to arrange the apparatus for pupils of varying degrees of deafness by placing certain of the earpieces, designed for very deaf pupils, in a primary circuit, and other earpieces, designed for moderately deaf pupils, in one or more secondary or induced circuits. It is also desired to provide for cutting certain earpieces or certain series of earpieces out of circuit with the teacher's receiver without disturbing the connection between the receiver and a certain other earpiece or series of earpieces when the teacher desires to give special instructions to a particular pupil or group of pupils. In carrying out the invention, the set includes a primary circuit embracing line wires and a plurality of bridge wires.



Audiphone Instruction Apparatus.

Pupils' switches are employed for electrically connecting the bridge wires with the line wires. Earpieces are arranged in certain of the bridge wires of the primary circuit and induction coils are located in certain others of these wires. A secondary circuit is provided including the secondary windings of the coils and earpieces are grouped in these secondary circuits. A teacher's receiver and a pupil's receiver are provided, also a teacher's and a pupil's key.

An improvement in electromagnets is the joint invention of August Sundh and David L. Lindquist, of Yonkers, N. Y., and is especially designed to prevent the

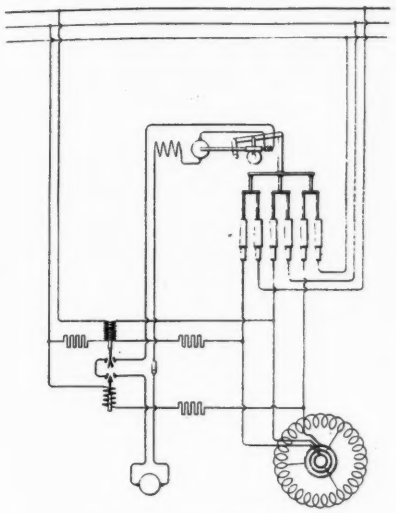


Electromagnet.

chattering and other noises commonly made by armatures or other mechanism set in vibration by an alternating current (791,591, June 6, 1905). The principle of the invention resides in causing the armature first to become magnetically equilibrated and then taking up by any suitable resilient means its vibrations due to current alternations in the magnet coil. In the embodiment of the invention, a vertically disposed solenoid frame is surrounded by a frame of magnetic material and is provided with openings coinciding with the axial armature opening in the coil. An armature is freely movable and detachably suspended in the coil and a resilient abutment receives the thrust of the armature when attracted by the solenoid.

John D. Hilliard, Jr., of Glens Falls, N. Y., has assigned to the General Electric Company, of New York, a patent recently granted to him on an improvement in synchronizing devices (792,035, June 13, 1905). The invention has relation to the synchronizing of alternating-current machines, and its object is to provide synchronizing means which shall act automatically to close the circuit of an alternating-current machine at the instant it is exactly in phase with the source of current to which it is to be connected. The invention consists in supplementing the effect of the two electromotive forces of currents ordinarily employed derived from corresponding phases of two ma-

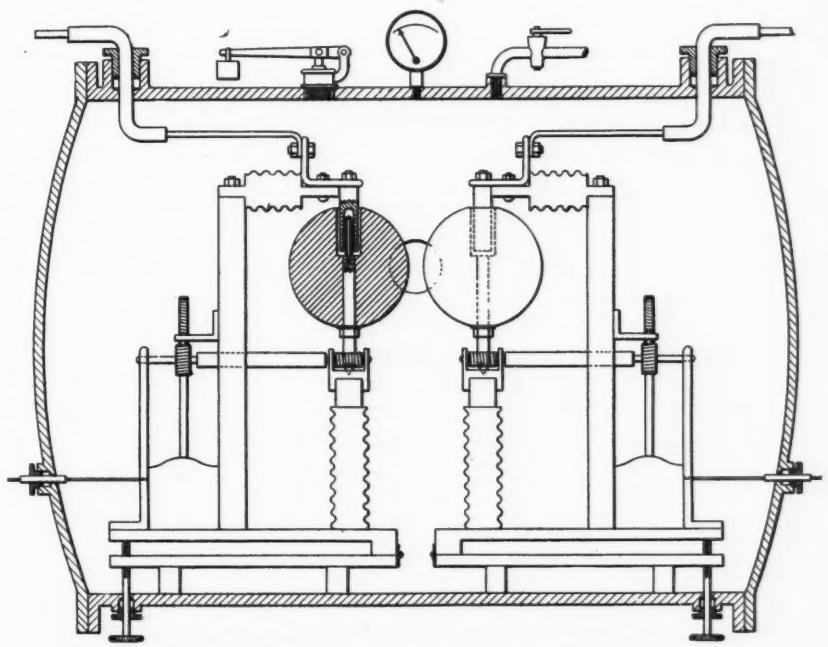
chines with a third current or electromotive force out of phase with the other two, and so arranging the automatic switch mechanism that it is operated only by the simultaneous action of the devices controlled by the above-mentioned currents or electromotive forces. Since when



SYNCHRONIZING DEVICE.

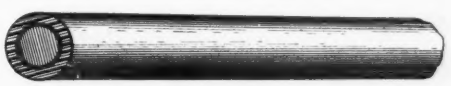
the first two currents or electromotive forces are at zero or maximum value, the other electromotive force is at an intermediate value in which an appreciable variation in magnitude is produced by a small variation in the phase-angle, a sensitive adjustment may be obtained. More specifically considered, the invention consists in the combination of a synchronous alternating-current machine and a switch for connecting it to a second machine or to the station bus-bars, an electroresponsive means for operating the switch, and two relays controlling the circuit of the electroresponsive means, one relay being controlled by the joint action of two currents derived, respectively, from corresponding phases of the one machine and the other machine or bus-bars, and the other relay being controlled by a current derived from different phases of the two machines.

A transmitting apparatus for wireless telegraphy has been patented in this country by John A. Fleming, of University College, London, England, and has been assigned by mesne assignments to the Marconi Wireless Telegraph Company, of America, a corporation of New Jersey (729,014, June 13, 1905). The object of the present invention is to produce, in connection with a transmitting apparatus, sparking terminals, one of which may be moved relatively to the other, whereby successive portions of the terminal or terminals are presented to the sparking point and also to produce a practically noiseless discharge. The improvements consist especially in combining the conducting bodies, between which the spark-gap is formed, with means whereby either or both of the conducting bodies will be moved, so as to continually present fresh discharge surfaces between the bodies. Any suitable connections may be employed for this purpose, and any desired form of sparking terminals may be used. In the present embodiment two spark-balls are used. Obviously, however, any suitable forms of sparking terminals may be used and either one or both may be moved relatively to the other. The balls may be replaced by any suitable shapes, but balls or discs of iron or other refractory conductors are preferably employed, being kept in rotation by means of clockwork or electric or other motors so that the places between which the discharge is taking place are constantly being changed. Arrangements are also made for replacing these surfaces, as required. These surfaces may consist of balls of iron or steel or iron discs, either solid or hollow, so that water may be made to circulate in the interior and keep them cool. The balls or discs are carried on shafts, which, in turn, are borne on insulating surfaces or bearings and they are placed at a proper distance apart for the discharge taking place, and arrangements are provided for regulating this distance. Preferably this is done by supporting each ball with its motor on a table pivoted about one edge, these tables being tilted more or less by means of screws.



TRANSMITTING APPARATUS FOR WIRELESS TELEGRAPHY.

An improvement in film-coated wires is the invention of John G. Callon, of Lynn, Mass., and is owned by the General Electric Company, of New York (792,001, June 13, 1905). The object of the invention is to provide a metallic conductor with an insulating coating which will add but inappreciably to the bulk of the conductor, will have high insulation, will be inexpensive to apply, and will not deteriorate at ordinary temperatures. The material which forms the main element of the coating is collodin. When applied



FILM COATED WIRE.

directly to a metallic wire, this substance produces an unsatisfactory insulation, since it is rapidly destroyed by high temperature, and, moreover, forms with the superficial oxide of the metal a nitric compound capable of acting on the wire. In the improved conductor-coating the wire is protected from direct contact with the collodin by a preliminary layer or layers of some material in the nature of a lacquer or varnish which completely covers it and excludes the succeeding layers of collodin or other nitrocellulose or mixtures thereof from coming in contact with the metal. A final layer of varnish can also be employed to protect the nitrocellulose from the air.

Reviews of Current Engineering and Scientific Literature.

Protection of Electrical Installations Against Excess-Pressure Rises.

An example of the disturbing influence on the pressure of switching in or out a transformer was shown in a test of a fifty-kilowatt, 5,000-volt transformer, which was fused with fuses blowing at about half an ampere. An electrostatic voltmeter reading to some 8,000 volts was used. The secondary circuit of the transformer was connected to the network. On closing the high-tension switch the fuses blew, the arc being quite a normal one. The voltmeter showed at this time, however, that the pressure must have been considerably above 8,000 volts. The strength of the primary current at the moment of opening the switch is not dependent upon the load of the transformer alone, but also upon the value of the electromotive-force wave at the instant the switch is opened. The switch used in the experiment was a quick-acting air-break switch. With an oil switch which breaks the arc at the instant when the electromotive-force wave is passing through its zero value, the current at that instant would be more or less reduced to zero, which is a very good argument for the use of oil-break, high-tension switches in preference to air-break switches. It is owing to this reason that an alternating current can be more easily broken than a continuous current of the same value and voltage. Where 500-volt motors have broken down it has been frequently observed that the voltage at the time of the accident jumped across an air-gap which was amply sufficient to withstand a much higher voltage. It is probable that the voltage has punctured a weak spot in the armature insulation, when, owing to the strong magnetic field, the resulting arc will be suddenly extinguished, thus giving rise to a high oscillating current in the windings. Thus, the machine windings would tend to act as a transformer, producing a voltage which would be in the neighborhood of 6,000 to 10,000 volts. It would therefore seem essential that all the installations should be provided with suitable excess-pressure arresters independent of the ordinary lightning arrester. The difficulty arises in this case from the fact that a spark-gap, in case of low-voltage installations, must be made very small, and such small gaps are readily bridged by dirt or insects. High resistances must be placed in series with the excess-pressure arresters, so that the current to earth is of so small a value that it does not in any way affect the normal voltage of the circuit, a small energy loss being quite sufficient to relieve the excess pressure. This is the main difference between the arrangement of the excess-pressure arresters as compared with the ordinary lightning arrester. It is not permissible to place a large resistance in series with the latter, as in a lightning discharge the amount of energy flowing is considerable. —*Abstracted from the Electrical Engineer (London), June* 9.

Signal Notes on the Queen & Crescent Route.

The Queen & Crescent route involves three distinct railway companies, of which the Cincinnati Southern is the busiest. It extends from Cincinnati to Chattanooga, Tenn., a distance of 336 miles. The road is single track, and has frequent curves of six degrees and gradients reaching in many places seventy feet to the mile. Very heavy traffic is maintained over this line with a remarkable freedom from accidents. This is due entirely to the efficient signaling system installed. The line is continuously controlled by block signals from the southern side of the Ohio river to Chattanooga. Interspersed are various interlocking plants, among which are several electric installations conducted by the General Railway Signal Company. The block signals constitute a history of the automatic form beginning with the first clockwork system, passing through the enclosed disc type, and finally reaching the purely electric and electro-gas semaphores as the present standards. The clockwork signal, although obsolete, has made a splendid record, and is still working under the same inspection and conditions as are the later forms. Its cost for maintenance is small, compared with the enclosed disc type, and after being installed nearly twenty years, it is still performing satisfactory work. Because of the difficulty and expense involved in construction, there are a number of short pieces of single track interposed between other pieces of double track. At these places the staff system is used. At one point a double track merges into single track through two tunnels, and over a bridge. Traffic over the single track is controlled by automatic block signals, irrespective of train rights and entirely without train orders. The first train to reach the junction point has the right of way. On the Cincinnati division the arrangement of signals approximates, as nearly as possible, to the ideal, and its efficiency falls very little below the theoretical perfection possible with the peculiar physical peculiarities of the line. This state of affairs has not been reached on the Chattanooga division, because the first installations of automatic block signals were for the protection of trains at isolated points, as tunnels and sharp curves at the bottom of heavy gradients. These gaps are being gradually filled in, and the entire system is being brought up to the perfection existing on the Cincinnati division. On the southern end of the double track the automatic signals are used both for blocking and for showing the position of the switches. The signals are controlled by track circuits and by circuit controllers, which latter are attached to a facing point lock-lever, so that signals can not assume a proceed position until the switch is set and locked for the desired route, and also until the track on the block in advance is clear. No distant switch signals are used between Cincinnati and Chattanooga, because the block signaling arrangements are complete, and all block signals are electrically connected with every switch which concerns them. On difficult or dangerous parts of the line, where watchmen are maintained, plugs governing the signals are placed in each watchman's shanty. These are to be used in case the track is obstructed by falling rock or a slide. They have proved themselves of great value in many instances. The signals themselves are of the motor type styles B and C of the Union Switch and Signal Company. The power is derived from batteries furnished by the Electric Storage Battery Company, of Philadelphia. The circuits are polarized with no line wires, and the maintenance of the system is therefore reduced to its simplest form.—*Abstracted from the Railway Age (Chicago), April* 28.

A Novel Type of Dynamo.

A type of dynamo suitable for the lighting of railway trains, as it will give a current of constant intensity without the aid of auxiliary apparatus, has been designed by Dr. E. Rosenberg, and is being brought out by the Allgemeine Elektricitäts Gesellschaft. The transverse field at right angles to the primary field in ordinary dynamos gives rise to inconvenient deformation of the main field. This trans-

verse field has been turned to practical use by the inventor. The dynamo is a two-pole machine which is practically identical with the ordinary machine, except that a second pair of brushes has been added. The brushes corresponding to those of the ordinary dynamo are short-circuited. The flux in the machine may be very small, in the event of the machine running at full speed. It will suffice, however, to induce a small electromotive force in the armature, and drive through the latter the normal current or part of it while the brushes are short-circuited. The armature current will produce a transverse field of much greater intensity than the primary field, and displaced ninety degrees in the direction of rotation. The armature reaction always weakens the field in the leading edge of the pole-shoes, reenforcing it in the trailing edge. If the main brushes of the machine be connected with any external resistance, the armature current derived from them will generate a field transversely with regard to the acting field, and in advance by ninety degrees in the direction of rotation. This tertiary field is displaced with respect to the secondary field by ninety degrees, and with respect to the primary field by 180 degrees in either direction of rotation. If the current derived from the main brushes be greater than the auxiliary current flowing between the short-circuited brushes, the tertiary field will be greater than the secondary field in the diagrams of ampere-turns. In order to allow the armature current to develop perfectly, a further number of ampere-turns should be arranged on the magnet system, accurately counterbalancing the back turns of the armature. If the machine were to be designed for ordinary purposes, the number of ampere-turns would be reduced by an additional main current winding so as to compensate for the armature reaction at any load. With machines intended for working in parallel with accumulators, and especially in the case of train-lighting dynamos, a different practice should be adopted. The primary exciter coils are connected to the accumulators, so that a number of balancing ampere-turns is present at the very outset. At medium speeds the number of ampere-turns required for generating the primary field is about ten per cent of that necessary for the armature compensation. The exciter coil thus receives a number of ampere-turns only greater by ten per cent than the number required for the compensation of the normal effective current, while the current flowing between the short-circuited brushes is about forty per cent of the normal effective current. Any increase in the latter weakens the primary field and accordingly weakens the magnetizing current between the auxiliary brushes. Though the speed may be increased up to double or a higher multiple of the average speed, the effective current in the armature will never increase more than ten per cent beyond its actual value. On reaching this value the armature ampere-turns will be perfectly equivalent to the primary ampere-turns, so as to leave no primary field. —*Abstracted from the Electrical Review (London), June 9.*

The Calcutta Tramway System.

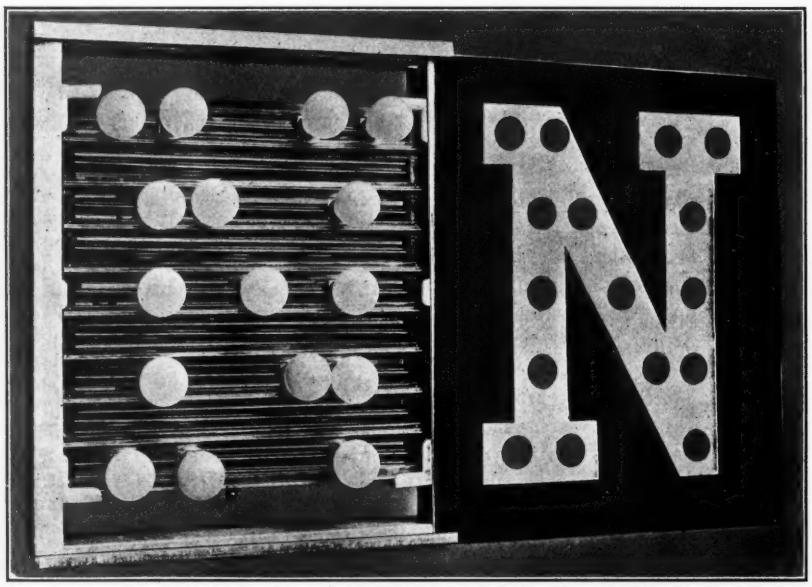
The tramway system in Calcutta, India, has been electrified. Steam was originally employed on some sections, and horse cars on the remaining sections, until 1901. The company operating the line received a concession dating thirty years from 1901, in consideration of the company's converting the system from horse to electric traction within three years. The electrification of the system was carried out according to the most modern plans as regards central station equipment, underground and overhead conducting systems, rolling stock, etc., and the plant was adapted to the peculiarities of tropical and local conditions. The route covers a total length of twenty-three route miles, double-tracked throughout. The cars on the various lines are run to either one of two termini. The first line under electric traction was opened for regular service on March 27, 1902, and the entire system was electrically operated on November 20, 1902. An exceptionally large increase of traffic immediately followed the opening of each section. The maximum number of trains operated at one time during an ordinary week day, with the present mileage, is 132. This number is increased to 145 on race days and festival days. The total number of passengers carried per year is about 21,000,000, each passenger traveling an average distance of about two and three-eighths miles. The track is laid standard gauge, with girder rails weighing ninety-five pounds per yard. Both centre and side-pole construction is used, and also span-wire construction. The feeder cables are paper insulated and protected by heavy lead shields, and are laid underground in cast-iron troughs on the solid system. The cables are supported in the troughs by wooden bridges, the troughs themselves being laid in a trench about eighteen inches in depth. The system is operated in trains consisting of one motor and one trail car. First-class passengers are carried in the motor car, and natives in the trail car. The equipment consists of 171 single-deck motor cars, ninety-six being of the open type. Each car is equipped with two twenty-five-horse-power motors and the usual accessories. The motors have had to stand very severe conditions, due to heavy rains which sometimes flood certain portions of the city to depths of over two feet in a short space of time. The generating equipment consists of three horizontal, cross-compound condensing engines, with a generator between the high and low-pressure sides. The engines run at ninety revolutions per minute with a steam pressure of 120 pounds per square inch. The engines develop, at the most economical operating point, about 675 horse-power. A supplementary unit consists of a Robb-Armstrong tandem-compound, 250-horse-power engine. This engine operates at 135 pounds steam pressure and a speed of 200 revolutions per minute. The generators are direct-connected to the larger machines. They were manufactured by Dick, Kerr & Company, and are of 550 volts, 500 kilowatts capacity each. The smaller generator has a capacity of 150 kilowatts. All generators operate at an efficiency of about 93.75 per cent. The switchboard is constructed of enameled slate, supported by an iron framework. It is placed on a gallery at one end of the engine room. The board consists of four generator panels, one main output panel, ten feeder panels, one lighting panel, one motor panel, three negative booster panels and one "Board of Trade" panel. Three negative boosters are installed, being directly connected to the track feeders. These are used whenever one part of the track return shows a greater drop than seven volts. The boosters have a respective capacity of 800 amperes at eighty volts, 300 amperes at 120 volts, and 300 amperes at seventy volts. The boiler equipment consists of six thirty-foot by eight-foot Galloway, and one Babcock & Wilcox boiler. The condensing plant is placed in the basement of the engine room, and consists of a surface condenser which deals with the exhaust from the three main engines and from the various steam-driven units. The circulating water is furnished by two electrically driven centrifugal pumps of 72,000 gallons per hour capacity each. The pumps are direct driven by thirty-five-horse-power motors. Two cooling towers are in operation, both supplied with fan draft. To provide sufficient power for additional trains which will have to be run to take care of the steadily increasing traffic, and also for trains on some new roads, some three-phase sets are being added to the power station. These will generate current at 6,600 volts, which will be distributed from several rotary converter substations connected to the works by duplicate three-core cables laid in separate troughs.—*Abstracted from the Electrician (London), June 9.*

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Changeable Signs.

The Mobile Electric Company, 30 Lawrence street, Newark, N. J., has placed on the market a new type of Mobile changeable sign. The principal feature of the construction of this sign allows of the wording being easily changed while the sign structure remains in position.

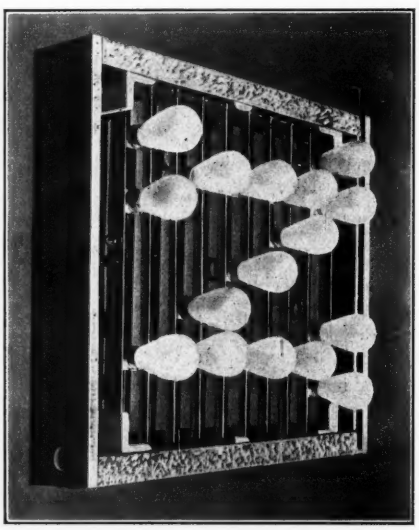


MOBILE UNIT, SHOWING METHOD OF ATTACHING FACE-PLATE.

The unit of the Mobile sign is a galvanized-iron box containing two frames or grids of parallel brass bars. These bars are insulated and held apart by porcelain corner and side pieces. The upper grid is constructed to form horizontal tracks for a specially devised lamp-holder or socket suitable for Edison-base lamps. The lower grid forms a series of ridges directly beneath the centre of the tracks in the upper grid. Thus a lamp screwed down through the open bottom of the socket forms a contact with the ridge in the lower grid and completes the circuit This makes up a wireless electric sign, the only wires used being the connections from the bottom of each grid, these connections being carried out through the entire length of the sign through ingeniously arranged conduits made integral with the box construction.

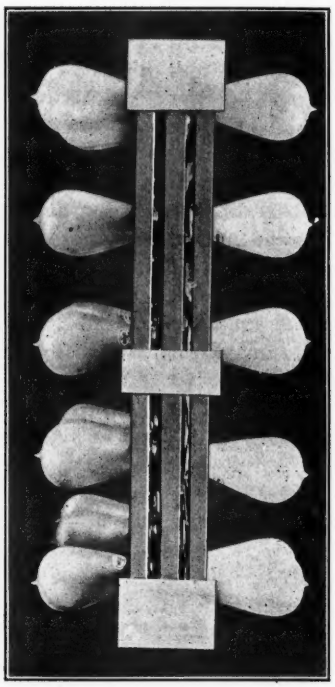
The sockets or holders are made in one piece of heavy brass, drawn and threaded to securely hold the lamp. The sockets are bent on the sides to form slots which engage tracks in the upper grid. These holders are easily sprung in in any desired number and at any point in the grid, and when in place slide horizontally on the tracks. In this way the lamps can be manipulated to form any desired letter.

Double-face units are made of three grids. The two outside grids form tracks for lamp sockets, and the centre ridges on both sides against which the bases of the lamps rest. Thus a different letter can be formed on each side of the unit, and the sign read from each direction.



OBLIQUE VIEW OF MOBILE BASE, WITHOUT FACE-PLATE.

Over each Mobile unit or base is fitted a steel face-plate. These are perforated for lamps and heavily enameled with a white letter on a background of blue or black. The face-plates are held by grooves at the top and bottom of the unit, and can be easily slipped in and adjusted. When in place they fit securely, protecting the interior from the elements.



END VIEW OF DOUBLE MOBILE GRID WORK, SHOWING LAMPS MAKING CONTACT ON INNER GRID.

Formation of the John Craig Hammond Advertising Company.

The John Craig Hammond Advertising Company, which will make a specialty of gas and electric advertising, has been organized in Denver by John Craig Hammond, formerly advertising manager of the Denver Gas and Electric Company. While the company will have the gas and electric business as its specialty, it will do a general advertising business as well.

Among the men associated with Mr. Hammond in the new venture are those who have been on his staff with the Denver company for more than a year and others who have been associated with him less directly and who have been working along similar lines. The members of the organization have spent a year in perfecting their plans. This has included a careful testing and investigation of the methods, which were devised especially for the gas and electric field, and are unlike any others.

New High-Efficiency Lamps.

A new line of high candle-power incandescent lighting units just announced by the General Electric Company signalizes a most important development in incandescent lamps in the production of a

FIG. 1.—"D" FORM REFLECTOR WITH HIGH-EFFICIENCY LAMP.

2.5 watts per candle lamp, measured by present standards of horizontal candle-power reading, and with a life equal to the present standard 3.1 watts per candle lamp. This signal improvement in the art of incandescent lamp manufacture marks a new era in the growth of incandescent lighting.

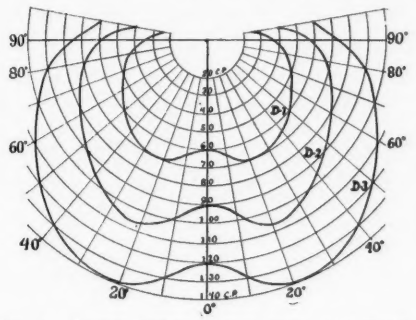


FIG. 2.—LIGHT DISTRIBUTION WITH "D" FORM REFLECTOR.

The actual gain is said to be twenty per cent greater efficiency than at present obtained from the highest efficiency incandescent lamps, on a basis of equal life. This improvement should materially assist central station companies in competing with Welsbach's and other similar illuminants, as an advantage equivalent to twenty per cent reduction in rates is thus gained.

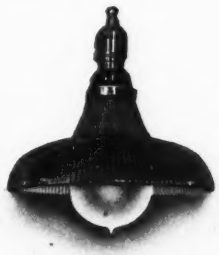


FIG. 3.—"C" FORM REFLECTOR WITH HIGH-EFFICIENCY LAMP.

The General Electric Company is developing these lamps first in the high candle-power sizes, in units of fifty candle-power (horizontal candle-power rating) and higher, to meet the demand for large lighting units, supplementing its Meridian lamps in the field of general illumination between the arc and the ordinary incandescent lamp. Appreciating the large gain in lighting efficiency that may be secured by the use of properly designed reflectors, the General Electric Company has designed a special line of Holophane Pagoda reflectors for use with the new high candle-power units. These reflectors are of the well known Holophane design, of prismatic glass, and when used with the lamps form a brilliant and highly efficient lighting combination of attractive appearance.

Two forms of reflectors are provided, the distributing or "D" form, shown in Fig. 1, giving a lighting distribution similar to that from the Meridian lamp, as may be seen in the diagram Fig. 2. This is the form of reflector for general use.

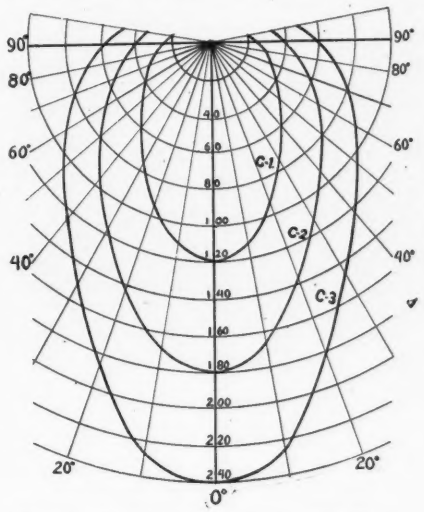


FIG. 4.—LIGHT DISTRIBUTION "C" FORM REFLECTOR.

The other form of reflector is known as the concentrated or "C" form, shown in Fig. 3, giving a concentrated distribution beneath the lamp, as outlined in diagram Fig. 4. This form of reflector is suitable for use in long narrow rooms with high ceilings, such as hallways, in window lighting, or wherever a concentration of light is desirable.

The lamps are at present supplied in three sizes as described in the following table. The appearance of the lamp is enhanced by having the bulbs frosted to within a short distance of the base. The lamps have larger bulbs than are at present used with standard lamps of similar candle-power and the life of the lamps is equal to that of the present standard 3.1 watts per candle lamps; that is, about 500 hours useful life, or 700 hours average life.

A new form of shade-holder has been devised by which the shades can be readily attached to or detached from the sockets.

Type Number.	Total Watts per Lamp.	Distributed Candle-Power in Downward Direction with "D" Form of Reflector.	Concentrated Candle-Power in Downward Direction with "C" Form of Reflector.
3	125	70, see curve D-1, Fig. 2	120, see curve C-1, Fig. 4
4	187½	105, " D-2, "	180, " C-2, "
5	250	140, " D-3, "	240, " C-3, "

New Works of Allis-Chalmers Company.

Allis-Chalmers Company has begun the great extensions to its already large works at West Allis, Milwaukee, and has awarded to James Stewart & Company, of Pittsburg, the contract for acting as supervising engineers and managers of construction for the entire undertaking. The American Bridge Company, of New York, has secured the contract for the structural steel, erected in place, for three of the new buildings, calling for approximately 6,800 tons of steel. The Riter-Conley Manufacturing Company, of Pittsburg, has been awarded the contract for the structural steel, erected in place, for the foundry and pattern storage buildings and erecting shops, comprising approximately 4,000 tons of steel.

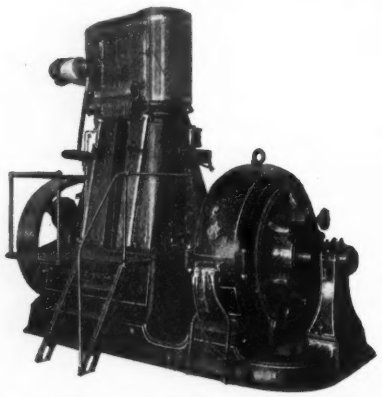
All of the structural steel for the new Allis-Chalmers works is to be delivered and erected within twenty-three weeks from the date of the signing of the contract. The company expects to occupy its new works by or before next March.

Some idea of the size of the works when extended will be afforded by the fact that the company's present floor space at West Allis, Milwaukee, has a total area of 652,000 square feet, and with the new extensions upon which work is now in progress will add 861,000 square feet or more than double the present capacity, making the total capacity at the West Allis works 1,513,000 square feet of floor space. The plant will be capable of affording employment for 11,000, thus, in addition to the capacity of the other works of the company in Milwaukee, Chicago, Cincinnati and Scranton, it will bring up the total number employed to the aggregate of 18,000 persons.

Interesting Results of an Engine Test.

During the academic year, 1904-5, a series of tests was made upon a Reeves vertical, cross-compound engine at Sibley College, Cornell University, Ithaca, N. Y. It was intended to determine the economy and mechanical efficiency, and to observe the general behavior of the engine under various loads and steam pressures.

The tests were made by Professor R. C. Carpenter, assisted by Professor H. Diederichs. The following data are embodied in their report to the Reeves



REEVES VERTICAL CROSS-COMPOUND ENGINE AT SIBLEY COLLEGE, CORNELL UNIVERSITY. ITHACA, N. Y.

Engine Company, Trenton, N. J., under date of May 13, 1905:

The engine is a vertical cross-compound. Steam is admitted to the high-pressure cylinder by a piston valve which takes steam from the inside edge. This valve is under control of a Rites shaft governor. The steam exhausted from the high pressure is admitted to the low-pressure cylinder by two piston valves of identical design, operated by an eccentric from the engine shaft. There is no receiver, and the steam from one end of the high pressure enters the same end of the low pressure. All the piston valves are so designed that, by means of expansion rings, wear can be taken up at either end of the valve by adjustment from the head end only, making it necessary to remove but one valve chest cover for each valve. Cylinders and valve chests are well lagged, and lubrication in the cylinders was taken care of by a sight-feed lubricator and hand pump.

The engine frame is of standard design, as are also cross-heads, rods and bearings. The whole engine gives one the impression of solidity and finish. There was, however, no indication whatever that the engine had been specially prepared for a "parade" test.

Lubrication of bearings is taken care of by a central oiling system, all oil pipes leading from a tank placed at the side of the cylinders. By this means, once the oilers are set, lubrication can be watched from one point.

The engine was connected through about twenty-five feet of four-inch pipe to two Babcock & Wilcox boilers. This pipe was one size too small, but was the largest that could be obtained for connection. In order to minimize the effect that the resulting high steam velocity would have, a piece of six-inch pipe about thirty inches long was interposed to act as a sort of reservoir just ahead of the throttle valve.

About twenty feet of seven-inch pipe connected the engine to a Wheeler surface condenser.

A Carpenter throttling calorimeter, placed beyond the throttle valve, served to determine the quality of steam. The steam pressure was determined by a gauge connected next to the calorimeter.

The speed was found by a continuous counter and by hand counter as a check. The continuous counter readings were used in the calculations as being absolutely correct.

One Thompson indicator was connected to each cylinder, taking cards from each end by means of a three-way cock. Motion for the indicators was obtained by fastening a rod to each cross-head, the stroke being reduced by means of a reducing wheel fastened to each indicator.

The condensed steam was pumped by the air pump alternately into two tanks on scales. Readings of condensed steam weights were taken every five or ten minutes, as the load demanded.

For the purpose of test the engine was fitted with a flywheel five feet in diameter on the low pressure side. Upon this wheel was placed the Prony brake for the determination of the developed horse-power. This brake was, in all respects, of the ordinary standard design, the strap being of steel plate, fitted with wood blocks on the inside. The wheel was kept as cool as possible by running cold water constantly into the flanged rim, and taking it out by a scoop. A steady small stream of cylinder oil led under the strap helped considerably in the smooth operation of the brake. By these arrangements as much as 185 developed horse-power was taken off one brake.

For the condensing series of tests as high a vacuum as could be obtained was carried. This averaged about twenty-four inches. For the non-condensing series the air-cock on the condenser was kept open, ensuring condensation under atmospheric pressure.

Indicated horse-power was computed from the well-known formula:

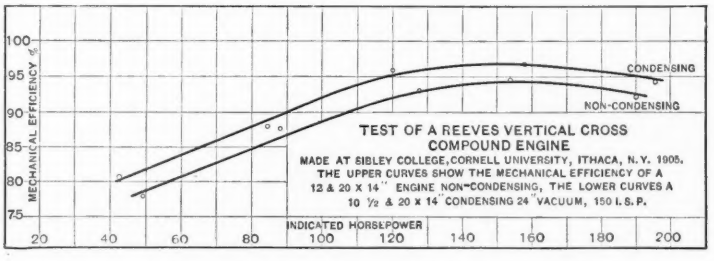
$$\text{I. H. P.} = \frac{p\,l\,a\,n}{33{,}000}$$

where

p = mean effective pressure
l = piston travel in feet per minute
a = area of piston in square inches
n = revolutions per minute

p was determined from the indicator cards. Depending upon the load, the indicator springs were changed.

For the condensing runs the engine dimensions were ten and a half inches and twenty inches by fourteen inches; for the non-condensing runs, twelve inches and twenty inches by fourteen inches. This change was effected by taking out a liner from the high-pressure cylinder. These dimensions make the cylinder ratio in the first case 3.60, in the second, 2.75.



EFFICIENCY CURVES OF REEVES VERTICAL, CROSS-COMPOUND ENGINE.

The developed horse-power was found from the brake constants by means of the formula:

$$\text{D. H. P.} = \frac{2\,\pi\,g\,a\,n}{33{,}000}$$

g = net loads in pounds
a = brake arm in feet
n = revolutions per minute

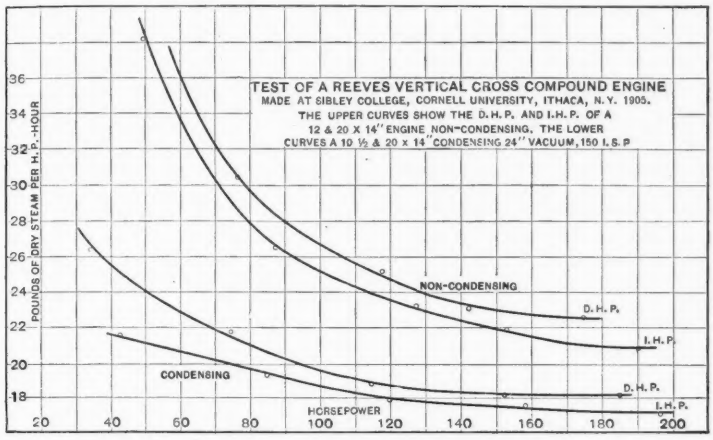
By a substitution of brake constants, the formula reduces to

D. H. P. = 0.001492 n for every 100 pounds of net brake load.

The steam consumption per indicated horse-power and per developed horse-

power for various loads and steam pressures is computed on the basis of dry steam.

For the purpose of facilitating inspection of results and discussion, the water


TEST OF A REEVES VERTICAL CROSS COMPOUND ENGINE
MADE AT SIBLEY COLLEGE, CORNELL UNIVERSITY, ITHACA, N.Y. 1905.
THE UPPER CURVES SHOW THE D.H.P. AND I.H.P. OF A
12 & 20 X 14" ENGINE NON-CONDENSING. THE LOWER
CURVES A 10 ½ & 20 x 14" CONDENSING 24" VACUUM, 150 I.S.P
POUNDS OF DRY STEAM PER H.P.-HOUR
NON-CONDENSING
D.H.P.
I.H.P.
CONDENSING
D.H.P.
I.H.P.
HORSEPOWER

HORSE-POWER CURVES OF REEVES VERTICAL, CROSS-COMPOUND ENGINE.

rates and mechanical efficiency are plotted on the accompanying curve sheets.

Two things are to be noted about these curves. The cut-off even at the high loads does not seem to be late enough to cause any marked rise in the steam consumption at overloads. In fact, in most cases little or no rise could be determined. Again, the curves show good economy over a wide range of load.

The mechanical efficiency curves show a steady increase with the load at any given steam pressure. On the overloads the efficiency falls off but slightly.

Lifting-Magnets.

The Electric Controller and Supply Company, Cleveland, Ohio, has introduced several new forms of lifting-magnets. The great success which has attended the introduction of the earlier types of lifting-magnets has opened up possibilities of new forms for performing all kinds of transferring and carrying in varying industrial operations.

These magnets are built for handling iron and steel in every form, including pig iron, light and heavy melting scrap, steel ingots, blooms, billets, slabs, plates, sheets, rails, structural shapes, spikes, rivets, cotter pins, etc.

A single design of magnet is not suitable for handling the full range of material above mentioned. The magnet must, in every case, be designed to suit the form of material to be handled.

In any installation an electromagnet is used suspended from the hook of an electric, steam, pneumatic or hydraulic crane, direct current at any of the common voltages of distribution being employed for energizing the magnet. Flexible cables —usually of the twin-conductor type— are used for conveying current to the magnet, and the only additional apparatus generally required consists of a simple controller or switch operated by the crane man.

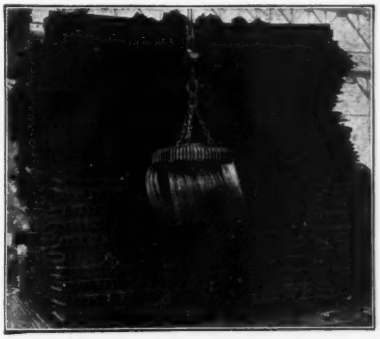
With the installation of a lifting-magnet the work of lifting and transferring the material to be handled becomes very simple. Instead of adjusting a number of chains or tackle of different nature, it is only necessary to drop the magnet upon the material, close the switch, and set the

LIFTING-MAGNET HANDLING RAIL ENDS.

hoisting apparatus in motion. When the material has reached the end of its travel it may be lowered to a convenient point, the circuit opened, and the load dropped.

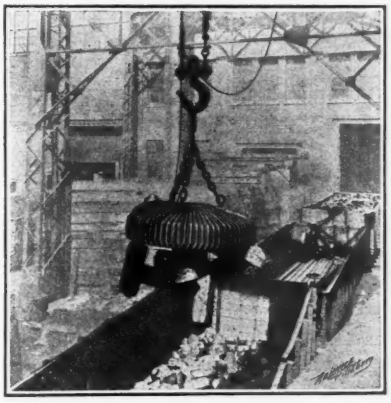
A very interesting application of the lifting-magnet is in connection with skull cracker work. The magnet lifts a ball weighing 11,000 pounds. The magnet is instantly attached by lowering on the ball. The ball is lifted and set over the point to be struck, and dropped accurately by simply opening the circuit.

The design of these magnets is the result of years of experience in building lifting-magnets. The case is a heavy casting



LIFTING-MAGNET HANDLING COILS OF WIRE.

made from such a grade of steel that when the circuit of the energizing coil is opened, the magnet drops its load instantly, so that no time is lost. The energizing coil is form-wound, heavily insulated and treated by a vacuum impregnating process, ensuring it against grounding or short-circuit. The coil is com-



LIFTING-MAGNET HANDLING BILLETS, UNLOADING AT HIGH SPEED.

pletely enclosed and protected by the case, which is ribbed to provide for the rapid radiation of the heat generated in the coil. Current is led to the coil through a heavily guarded plug connection. This plug is simply pulled out when it is desired to detach the magnet from the crane hook.

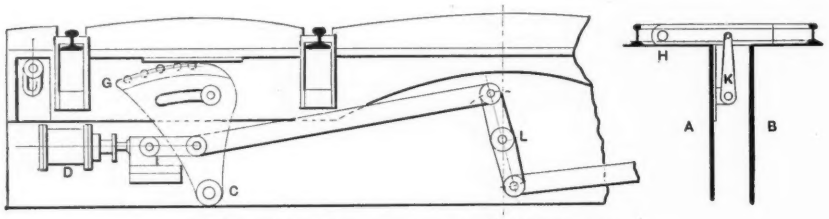
Fuel Briquetting Plant in Japan.

A plant for briquetting fuel has been located at Tokuyama, Japan. It is under control of the Japanese admiralty, which also controls the Omine mine which furnishes the coal for the plant. The plant started operations on April 24. Its normal capacity is about 150,000 tons per annum, although this can be doubled if occasion requires. The cost of the briquetting coal at the plant is about $4.50 per ton. The plant cost $500,000, the machinery being purchased in England.

Track-End Adjustment for Drawbridges.

The accompanying illustration shows a new form of track-end adjustment for drawbridges, designed by Jacob Harsen, of New York city. Some drawbridges have the rail flush with the moving and fixed ends of the structure. Necessarily, a gap must be left to allow for expansion. In this case the car must jump the space, and this causes a heavy pounding which splits the rails and sometimes derails the car by missing the rail through improper adjustment of the draw.

As will be noticed from the drawing, the rails are fastened to a vertical moving frame by the link K. The rail is pivoted, and normally rests on both the moving and stationary structure. D is a hydraulic cylinder connecting with the cam moving on the pivot C. When the piston moves out the cam swings, and the frame is supported by the end G and raised. The hydraulic arrangement is used for hydraulically operated bridges. Should it be a double-track bridge, another set of rails is added on the same frame. A second cylinder and cam are used, and this cam moves in the opposite direction, so as to obviate any side thrust. Hydraulic cylinders are not a necessity, as any form of motive power can be applied. In the case of a motor, the power will be applied at the point L. With this device the joint may be lapped so that the car is on the other rail before it leaves the first; and in this case a higher speed is permissible without danger.



TRACK-END ADJUSTMENT FOR DRAWBRIDGES.

Steam Turbine Equipments for Railway Service.

The Brooklyn Heights Railroad Company has recently closed contracts with the Westinghouse Companies, Pittsburg, Pa., for two 7,500-kilowatt turbine type generating units for extending its present power-house equipment in Brooklyn. These units will be the largest generating units of the turbine type in the world. With the guaranteed overload capacity of fifty per cent above rating, the turbines will thus be capable of developing 16,000 brake-horse-power and about 10,500 brake-horse-power on normal load. The turbines will operate on dry steam at 175 pounds pressure and a vacuum of about twenty-eight inches. Three-phase, twenty-five-cycle current will be generated directly at 11,000 volts for distribution to the line.

It is of interest in this connection that the second and third largest turbine generating units in the world are also of the Parsons type, the former built abroad and the latter by the Westinghouse Companies at Pittsburg. The Brooklyn Heights contract is especially significant from the fact that the company had already contracted about a year ago for a Westinghouse-Parsons turbine unit of the largest capacity then built, 5,500 kilowatts. The building of the new machines will mark an important step in the development of power station apparatus.

An important contract for a 10,000-horse-power power-house equipment has just been awarded to the Westinghouse Companies, Pittsburg, Pa., by the Fort Wayne & Wabash Valley Traction Company, of Fort Wayne, Ind. The entire electrical equipment, comprising both three-phase and two-phase apparatus, the former for railway and the latter for lighting service, will be built by the Westinghouse Electric and Manufacturing Company and the steam turbines by the Westinghouse Machine Company.

The principal apparatus covered by the contract comprises two 1,500-kilowatt and one 400-kilowatt turbo-generator units, delivering 375 volts, three-phase, twenty-five-cycle current to rotary converters; two 1,500 and one 500-kilowatt turbo-units, delivering 2,300 volts, two-phase, sixty-cycle current to step-up transformers for the lighting system. Four rotary converters; seven 375-kilowatt, fifteen seventy-five-kilowatt, six 100-kilowatt, and three 150-kilowatt, oil-insulated, self-cooling transformers; four switchboards for 125, 550, 600 and 2,300 volts; and low-equivalent lightning arresters, choke coils, disconnecting switches are included in the equipment.

The steam turbine equipment is to be of the standard Westinghouse-Parsons type, operating under 150 pounds steam pressure, a moderate vacuum and with dry saturated steam. Many distinctive features will be embodied in the arrangement of the new power-house now building.

The Fort Wayne & Wabash Valley Traction Company controls all the city lines in Fort Wayne and Lafayette, Ind.; the Logansport Street Railway Company and the Logansport, Rochester & Northern Traction Company in Logansport; the Fort Wayne & Southwestern Traction property from Fort Wayne to Wabash; the Wabash River Traction Company and the Wabash-Logansport Traction Company, operating from Wabash to Logansport, and the electric lighting plant in Fort Wayne.

Contracts have also been closed with the Westinghouse Companies by the Grand Rapids-Muskegon Water, Power and Electric Company, of Grand Rapids, Mich., for two 1,500-kilowatt, three-phase, 6,600-volt turbo-generator outfits with two twenty-kilowatt, engine-type exciters. The voltage will be raised for transmission by three 1,000-kilowatt, oil-insulated, water-cooled transformers, and finally lowered for distribution by three transformers of the same size and type. The apparatus will be controlled from a 660 and a 6,600-volt switchboard.

A New Fuseless Attachment Plug.

A fuseless attachment plug has been added to the line of National Electric Code standard specialties made by the Peru Electric Manufacturing Company, Peru, Ind. The principal feature of this plug is its simple and correct design,

FUSELESS ATTACHMENT PLUG.

giving it a neat appearance, safe construction and labor-saving characteristics.

There is one screw holding the cap to the base, and this screw is secured in the cap by a small washer. The terminals in the base are separated by a porcelain wall, eliminating the possibility of short-circuit. The cap is hollowed out to accommodate a knot in the cord, and the hole in the cap will take the new code reenforced cord.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

NEW POWER PLANT IN MONTANA—The Missouri River Power Company proposes to build a dam across the Missouri river and to erect a power plant. The power generated will be transmitted to Helena and Butte and intermediate points. The estimated cost is $1,000,000.

DEVELOPMENT OF THE FALLS OF THE CATAWBA RIVER IN SOUTH CAROLINA—Plans are completed for the development of the great falls on the Catawba river near Chester and Winnsboro, S. C. The development calls for an investment of $3,000,000. The company has acquired properties extending up and down the river for a distance of eight miles, and controls 173 feet of fall. The total horse-power to be developed is estimated at 75,000. The work is to be undertaken at once, and it is expected that it will be completed within eighteen months. Power will be transmitted at 44,000 volts to Gaston and to Charlotte. The falls are being developed by the company which owns the Wateree river water power near Camden.

ELECTRICAL NOTES FROM MEXICO—The municipal electric light plant of the city of Moralia, capital of Michoacan, has been sold to a private company for the sum of $80,000. The plant was originally operated by steam power, but the new owner proposes to develop the San Pedro fall, from which it is estimated 2,000 horse-power can be secured. The company pledges itself to use hydraulic power within two years. The number of street lights in the city is to be increased, and the rates cut. The engineering firm of Santa Cruz & Olivier has applied for a concession to utilize the water existing in the arroya known as Xuchiles, in the canton of Cordova, state of Vera Cruz. The point at which it is proposed to erect the plant is on the line of the Vera Cruz & Pacific Railroad, twenty-four kilometres from Cordova.

ORGANIZATION OF THE MEXICAN ELECTRIC LIGHT COMPANY, LIMITED—The Mexican Electric Light Company, Limited, has been organized and will take over the Mexican Light, Heat and Power Company, which has been formed by the consolidation of two other electric light companies in Mexico City. The new company has issued bonds to the amount of $6,000,000, of which $5,500,000 has been underwritten at ninety. The Mexican Light, Heat and Power Company guarantees the interest on the new bond issue, which will be five per cent. The present yearly revenue of the companies comprising the Mexican Light, Heat and Power Company amounts to $450,000. The president of the new company is Mr. James Ross, and the directors will be the men forming the directorate of the Mexican Light, Heat and Power Company. The company will supply 5,000 horse-power to the street railway of the city of Mexico, and 2,000 horse-power to the Mexican government for pumping purposes.

POWER PLANT PROJECT IN CANADA—The Electric Development and Securities Company, of New York, and the International Electrical Securities Company, of Toronto, which have acquired the charter of the Niagara-Welland Power Company, have had a surveying party in the field recently preparing for the generation of the power. The proposed power-house is to be four miles east of St. Catharines, where a fall of 210 feet can be secured. The water is to be brought to this point by a canal eight miles long from the Welland river. The water is to be conducted from the power-house by a tailrace six miles to lake Ontario. The canal is to be of sufficient size to provide water for the development of 100,000 horse-power. Surveys have been completed for the canal, and also for the right of way of the transmission line, which will pass through the towns of Brantford, Woodstock, Ingersoll, London, Paris, Galt, Preston, Hespeler, Guelph, Berlin, Waterloo, New Hamburg and Tavistock, and another circuit will embrace Hamilton, Dundas, Milton, Brampton and Toronto. Recent investigations have been in charge of Mr. John MacCunn.

THE HYDROELECTRIC PLANT OF THE VANCOUVER POWER COMPANY COMPLETED—The immense tunnel and hydroelectric plant built by the Vancouver Power Company at lake Coquitlam, Vancouver, B. C., have been completed, and will soon be ready for operation. The tunnel connecting lake Coquitlam with lake Beautiful has been finished, and work will be steadily pushed until final construction details of the power plant are completed. The Vancouver Power Company is capitalized at $1,225,000. It was incorporated in 1898. Lake Beautiful is thirty feet lower than lake Coquitlam, and is to be used as a balancing reservoir to make up any deficiency which might ensue from a dry season with only lake Coquitlam to depend upon. The dam is situated about half a mile below the lake Beautiful portal of the tunnel. It is 361 feet long on the crest, and fifty-four feet high. It is built entirely of concrete, and cost over $50,000. Provision has been made for ten pipe lines, to extend from the dam to the power-house, a distance of 1,800 feet. As yet only three of these pipe lines have been built and put in operation. The upper 800 feet of the pipe lines are constructed of wooden stave piping fifty-four inches in diameter. The lower 1,000 feet are of steel, ranging from forty-two to forty-eight inches in diameter. The power-house is located at sea level. It is built on a foundation blasted out of the solid rock of the mountain side. The building is entirely of concrete of massive structure, the walls being three feet thick. The dimensions are 156 by 34 feet. It has a capacity of four units of 3,000 horse-power each. Three of these are in operation. The installation consists of Westinghouse generators driven by Pelton water-wheels. Current is generated at 2,000 volts, and raised to 20,000 volts for transmission. At the substations it is reduced to a lower voltage for commercial distribution.

THE HAVANA (CUBA) CENTRAL RAILWAY SYSTEM—The Havana Central Railway Company, of Havana, Cuba, has placed orders with the foreign department of the General Electric Company, of Schenectady, N. Y., for complete electrical equipment of a network of interurban electric railway lines radiating from Havana and covering an extensive territory inland. The system will consist of a central power-house in Havana and eight outside substations together with line material for about 125 miles of trackage and rolling stock for passenger and freight service over the entire system. The power-house in Havana will furnish 5,000 kilowatts—19,000 volts, twenty-five cycles, three-phase alternating current—generated by two 2,000-kilowatt generators and one 1,000-kilowatt Curtis steam turbine generator at 2,200 volts, stepped up through air-blast transformers to line voltage. The transmission lines will parallel the various lines of the railway to the substations where step-down transformers supply low voltage to rotary converters furnishing 600 volts direct current to trolley lines and feeders. From Havana one branch will run southeast through Cuatro Caminos, Lomas de Candela, Guines, Providencia to Rosario, a distance of about forty miles. Substations will be located at Cuatro Caminos, Lomas de Candela and Providencia. A second line will run from Havana seventeen miles south to Bejucal with a substation on the line at Santiago de las Vegas. A third line running southwest from Havana to Mariel will have a length of thirty-seven miles and branch lines running north and south of El Carmelo, Santiago de las Vegas and Tuira de Melena amounting to about thirty miles in addition. Substations on the line to Mariel will be placed at Marianao, Hoyo Colorado and Guanajay and at San Antonio Melena. The rolling stock for passenger service will consist of twenty-four thirty-ton cars seating fifty passengers and equipped with four GE-74 motors geared for a maximum speed of forty miles per hour. The freight service will be handled by ten forty-ton General Electric locomotives equipped with four GE-55 motors geared for a speed of seventeen miles per hour when hauling a 300-ton train. The entire system will have double overhead trolley both in Havana and on the interurban lines. The high potential transmission lines will be designed for a future potential of 30,000 volts to provide for extensions. The transformers in the Havana power-house and in the substations are also suitable for use on the increased potential. It is expected that the entire system will be in operation inside of eighteen months and that portions of it will be giving service before that time.

ELECTRIC RAILWAYS.

KLAMATH FALLS, ORE.—The Klamath Falls trustees have granted an electric railway franchise to A. N. Noftzger.

COFFEYVILLE, KAN.—Work has been begun on the new electric railroad between Coffeyville and Independence. The line will traverse the principal streets of Coffeyville and Independence.

UXBRIDGE, MASS.—The Uxbridge & Blackstone Street Railway Company has begun running cars over the new extension of the line, from Linwood to Plummers Corner, making a continuous line of street railways from Worcester to Providence.

QUEBEC, QUE.—The Levis electric railway has been sold at sheriff's sale, in the Quebec court house, to John Foreman, of Montreal, for $50,000. The sale has been made in the interest of the shareholders, whom, it is said, were represented by Mr. Foreman.

HAMILTON, MONT.—The county commissioners have granted a franchise to David Bishop, of Hamilton, and George Dougherty, of Missoula, for an electric road, to run between Hamilton and Missoula. A number of eastern capitalists are interested in the road.

DEFIANCE, OHIO—The Defiance, Wauseon, Adrian, Ann Arbor & Detroit interurban road, a line to run from Defiance to Detroit, with general offices at Wauseon, has been financed by a syndicate of eastern capitalists. Active construction work will be commenced at once.

GALION, OHIO—W. L. Ball, promoter of the Galion Southern electric railway, announces that the bonds have been floated and the right of way secured. It is expected that construction work will soon begin. The road will run from Galion, *via* Fredericktown, to Mount Vernon.

FREDONIA, N. Y.—Heirs of the late M. M. Fenner have sold their interest in the Fredonia & Dunkirk trolley railway to Pittsburg residents. This estate held a controlling interest. It is expected that other stockholders will also sell. The road with its adjuncts is worth about $300,000.

NORWICH, CT.—The railroad committee of the legislature has made a favorable report on the resolution incorporating the Lebanon Street Railway Company. The charter authorizes the company to construct and operate a street railway in the towns of Norwich, Bozrah, Franklin, Lebanon and Columbia.

CLEVELAND, OHIO—Contracts have been let by the Cleveland Electric Company for the excavation and substructure of the addition to be erected at the Viaduct power station of the company. The addition will increase the capacity of the power station about one-fourth. The building and machinery to be installed will cost about $250,000.

CINCINNATI, OHIO—Contracts have been let by the Cincinnati Northern Traction Company, the lessees of the Cincinnati, Dayton & Toledo Light and Traction Company, for the erection of a new power plant in Hamilton, Ohio, which will cost $650,000. This plant will take the place of five small power stations distributed along the line, and will effect an enormous saving in expense.

BOSTON, MASS.—The Danbury & Harlem Traction Company has awarded the contract for completing the trolley line from Danbury, Ct., to Golden's Bridge, N. Y., and operations have begun. The power necessary to operate the company's cars will be secured, it is understood, from the Danbury & Bethel Street Railway Company until the Harlem company's power-house has been completed.

MILWAUKEE, WIS.—Two grading gangs have been placed at work on the proposed extension of the Milwaukee Electric Railway and Light Company's system from Waukesha Beach to Oconomowoc. President John I. Beggs announces that he expects to have the new line open by May 30, 1906. The distance to be covered is about fourteen miles. The line will be eventually built to Watertown.

ALBANY, N. Y.—The state board of railroad commissioners has given a decision granting the application of the Long Island Electric Railway Company that a single track of its double-track road may cross at grade the three tracks of the Long Island Railroad Company at a point where the latter road crosses at grade the Jamaica and Hempstead turnpike highway east of Queens, Borough of Queens.

INDIANAPOLIS, IND.—The Indianapolis, Newcastle & Toledo Electric Railway Company announces that agents of the company have obtained options on land for the entire right of way of the proposed electric railway. This right of way is one hundred feet in width and forty miles in length. It is said that the plans of the company contemplate the actual beginning of work within a few months.

ST. JOSEPH, MO.—Mrs. Alice M. Butler, general manager of the proposed St. Joseph, Stanberry & Northern electric line, has signed a contract with a St. Louis trust company to advance $566,000, two-thirds of the estimated cost of constructing the line. The remaining third will be advanced by persons and interests in St. Joseph, Stanberry, Des Moines and other points. The estimated cost of building the line is $850,000.

WINNIPEG, MANITOBA—The construction of a Winnipeg station house, in connection with the line of the Winnipeg Light and Power Company, has been commenced. This station will be 70 feet by 180, two stories in height, built of brick and steel. It will be situated at the Winnipeg terminal of the line now being strung from Lac du Bonnet, which it is thought will be in readiness to deliver power to the city by October.

PORTLAND, IND.—The Commercial Club has agreed to give a free right of way from Portland to the Adams County line to the Fort Wayne & Springfield Traction Company, now building between Fort Wayne and Decatur, and purposing to extend to Portland. The work of securing the right of way over the nine miles between Portland and the county line has been begun. The company has also asked a franchise from the county.

NEW CASTLE, PA.—The people who are working in an endeavor to merge the Pennsylvania & Mahoning Valley Street Railway Company and the Sharon & New Castle and Sharon & Youngstown Street Railway companies into one company have caused to be organized what is known as the Mahoning & Shenango Railway and Light Company. This organization has been effected in Youngstown with an initial capital stock of $10,000.

SALT LAKE CITY, UTAH—A movement is now well under way, headed by John P. Cahoon, to purchase from the Utah Light and Railway Company the Murray-Salt Lake line, together with lines through the city or traffic arrangements over some of the lines of the present company. A part of the movement is a guarantee of a five-cent fare from Murray to any part of Salt Lake City, and from any part of Salt Lake City to Murray.

ALBANY, N. Y.—The Buffalo, Lockport & Rochester Railway Company has filed with the secretary of state articles of agreement of consolidation of these roads: Albion Electric Railway, Albion & Rochester and Albion & Lockport Railway. The capital is $590,000, and the principal office is in Buffalo. The directors are F. B. Griffith, Jr., Charles B. Hill, of Buffalo; Lorenzo Burrows and George B. Church, of Albion, and R. A. Adams, of Rochester.

RIVERHEAD, N. Y.—The officials of the Pennsylvania Railroad, operating the Long Island Railroad system, are said to be favorably considering the construction of a new trolley line which will run from Wading river to Mattituck, eighteen miles. The proposed route has been surveyed. The line will run through the northern part of Riverhead, and will parallel the Long Island sound for several miles. It will connect the Wading river branch of the railroad with the main line.

ROCKFORD, ILL.—Stockholders of the Rockford Belt Railway Company are to meet in special session in the office of the company, in Chicago, August 15, for the purpose of taking action on several propositions, as follows: to increase the capital stock from $100,000 to such an amount as may be authorized by the stockholders, but not to exceed the sum of $1,000,000. To act upon a proposition to issue first-mortgage bonds to such sum as may be authorized by the stockholders, but not to exceed the sum of $1,000,000.

SALISBURY, N. C.—In a reorganization of the Salisbury-Spencer Railway Company just effected, the election of the following offi-

cers is announced: president, E. M. Deane, of Grand Rapids, Mich.; vice-president, N. B. McCanless, of Salisbury; general manager, Harry B. Wales, of Michigan. It is expected that the car line running between Salisbury and Spencer will be put in operation within the next thirty days. The line will also be extended to Chestnut Hill at an early date. Much of the material necessary for this work is already on hand.

MIDDLETOWN, CT.—The legislative committee on railroads has made a favorable report on the bill incorporating the Hartford, Middletown & New Haven Railway Company. The incorporators are F. D. Haines, of Middletown, and L. D. Parker and G. C. F. Williams, of Hartford. The company has a maximum capital stock of $500,000. The franchise which the company seeks for the construction of a street railway from Hartford to New Haven, with some digressions, is a valuable one. It authorizes the company to build and operate an electric road in the towns of Wethersfield, Rocky Hill, Cromwell, Middletown, Middlefield, Durham, North Branford and Guilford.

MIDDLETOWN, CT.—Engineers representing the Consolidated Railway Company are making a survey for the proposed trolley line between Middletown and Meriden. The distance is eleven miles, but only five miles of new construction will be necessary. For the other six miles the steam tracks of the Middletown, Meriden & Waterbury Railroad, which will be equipped with an overhead electric system, will be used. The cost of the road is estimated roughly at $175,000. According to present plans the work of construction will be undertaken this summer. It is expected that when the road is completed the running time between the two cities will be approximately forty minutes.

ATLANTA, GA.—Work is actively in progress for a trolley line between Atlanta and Macon. Application for a charter for the Atlanta Construction and Development Company, which will do the work of building and maintaining the road, has been filed at Atlanta. An application for a charter of the Atlanta-Macon Interurban Railway Company, has been filed with the secretary of state. The capital stock is $100,000. The proposed electric line will run from Atlanta to Jonesboro, Hampton, Griffin, Barnesville, Forsyth and Macon, a distance approximately of 100 miles. The construction company will have a capital stock of $50,000, and asks the right to increase at any time to $2,000,000.

TOLEDO, OHIO—The contract for the construction of the Toledo, Ann Arbor & Detroit Traction line has been awarded to the Fidelity Construction Company, of Detroit. Work on the new line will be commenced at once. The proposed line will extend from the western limits of Toledo to Ann Arbor, Mich., about forty-three miles. It will parallel the Ann Arbor (steam line) the entire distance, passing through the towns of Dundee and Milan. The work will be done under the direction of the Patrick Hirsch Construction Company, which, it is understood, is giving the proposition financial backing, and which is just completing the extension of the Toledo & Indiana from Wauseon to Bryan.

INDIANAPOLIS, IND.—Carrying out its general plan for a big system of interurban railroads in the northern part of the state, radiating from Warsaw, the Winona Assembly Association has filed articles of incorporation for the Winona Interurban Railway Company. The capital is $500,000, divided into five thousand shares of $100 each. On the board of directors are the following men, all of whom are prominently connected with the Winona Assembly: Thomas Kane, William M. Kamp, H. J. Heinz, E. T. Yarnelle, J. F. Beyer, L. F. Marshall, Col. C. Dickey, J. M. Studebaker, William O. Frazer, A. M. Dukes, J. E. Beyer, A. McDonald, A. P. Burchfield, F. J. Torrence, C. H. Worden and E. A. K. Hackett.

EVANSVILLE, IND.—The Evansville & Princeton Traction Company has mortgaged its right of way, rolling stock and other property to the American Trust and Savings Company, of Evansville, for $700,000. Seven hundred five per cent $1,000 coupon bonds, to run from April 1, 1905, to April 1, 1925, will be issued through the banking company. The money is to pay off the outstanding indebtedness of the company, consisting of $400,000 in six per cent bonds issued when the road was built, and to provide $300,000 additional for the construction of new lines and the ballasting of the road-bed besides making other improvements. The trust company is made trustee of the road for twenty years, and the title of the line will be changed from the Evansville & Princeton Traction Company to The Traction Company.

LEOMINSTER, MASS.—Worcester, Princeton, Fitchburg, Holden and Wellesley capital is interested in the formation of the new Fitchburg & Princeton Street Railway Company, which is being organized with a capital stock of $60,000, and is to build a road beginning at the location of the Worcester & Northern Street Railway Company in Princeton, to extend through Princeton, Westminster and Fitchburg to the tracks of the Fitchburg & Leominster Street Railway Company in Fitchburg. The length of the line of the new company will be six miles, and the following are to act as a board of directors until others are elected by the corporation: Henry W. Warren, Holden; Henry C. Delano, Princeton; H. C. Beaman, Princeton; John H. Daniels, Fitchburg; John H. Shea, Fitchburg; A. R. Clapp, Wellesley Hills; Charles C. Milton, Worcester.

WINCHESTER, VA.—Henry Pressey, of Washington, D. C., and N. Wilson Davis, of Harrisonburg, Va., are making final surveys and investigations of probable power from the Shenandoah river, in Clarke County, for the projected Winchester & Washington electric railway, for which a charter was recently granted by the Virginia corporation commission. It is proposed to run the new road through *via* Ashby's Gap, in the Blue Ridge, passing Bull Run, where a $50,000 summer hotel will be erected by a syndicate of Washington and Virginia capitalists. It is expected that work on the line will begin this summer. Among those interested are Frank Carpenter, Holmes Conrad, of Winchester; Charles Thurman, A. Moore, Jr., and Charles Mullikin, of Clarke County, and W. H. Baker, Lewis F. Cooper, S. H. Hansbrough, Shirley Carter, S. L. Hoover and W. S. Love, of Winchester.

WILLIMANTIC, CT.—The senate has passed the resolution incorporating the Willimantic & Stafford Springs Electric Railway Company. The company is authorized to construct a trolley line in the towns of Windham and Mansfield in Windham County, and in Willington and Stafford in Tolland County. It has a maximum capital stock of $700,000, and is authorized to take unused water powers in the towns of Windham, Mansfield, Ellington, Coventry, Willington and Tolland. It is empowered to sell its surplus electricity for light and power purposes anywhere outside the territory in which regularly organized companies now operate. The incorporators are Charles W. Comstock, of Montville, and Edwin W. Higgins, of Lewellyn, W. Storrs and Costello Lippit, of Norwich. The charter is a broad one, and most of the territory in which the road proposes to operate is isolated from street railway facilities.

HARTFORD, CT.—The legislative committee on railroads has made a favorable report on resolutions creating two trolley corporations. One of the measures incorporates the Norwich, Jewett City & Voluntown Street Railway Company. The corporation has an authorized capital stock of $700,000, and is empowered to carry freight and express matter as well as passengers. The route begins at the intersection of the tracks of the Consolidated Railway Company in Norwich, and runs through Preston City, Jewett City, Griswold, Glasgow and Voluntown. The other resolution provides for the incorporation of the Willimantic & Stafford Street Railway, with a maximum capitalization of $700,000. The company is granted the right to operate in the towns of Windham, Mansfield, Willington and Stafford, but the main line which it proposes to build will run from the city of Willimantic to the borough of Stafford Springs.

HARTFORD, CT.—The transfer of the trolley line of the Hartford, Manchester & Rockville Tramway Company to the American Loan and Trust Company, of Boston, made public several weeks ago, has been officially announced. The trust company's purchase is in the interest of the Hartford, Springfield & Worcester Electric Company, controlled by the same interests as now own the Boston & Worcester Electric Company. It is announced that the road will be used as the terminus of the proposed through line from Boston to Hartford, and that the construction of a road to fill the gap between Rockville and Worcester will be begun at once. This connecting link will be built by the Stafford Springs Street Railway Company, which is controlled by the Boston & Worcester company. James F. Shaw, of Manchester, Mass.; Walter H. Turnbull, of Salem, Mass., and George A. Butman, of Malden, Mass., are among the promoters of the enterprise.

ELECTRIC LIGHTING.

FREEPORT, N. Y.—A 100-kilowatt generator is to be purchased for the electric light plant.

CASPER, WYO.—The town council is considering a proposition to purchase the local electric light plant.

ALEDO, ILL.—A franchise for electric lighting has been granted to Bolton Bros., for a period of twenty years.

CARROLLTON, OHIO—Municipal ownership of the electric light plant was defeated on June 17 by a vote of 113 to 263.

CHEHALIS, WASH.—Harry West will erect a 400-horse-power electric plant on Coal creek, one-half mile from Chehalis.

SNOHOMISH, WASH.—The Snohomish electric light plant has been totally destroyed by fire. The loss is $10,000, partially insured.

TIPTONVILLE, TENN.—Papers are prepared for a fifteen-year franchise for an electric light plant to be in operation by September 1, 1905.

TRENTON, MICH.—The Peninsular Electric Lighting Company has made a contract with Trenton council to furnish the village with lights.

MT. STERLING, KY.—A franchise for an electric light plant and telephone system at Grayson has been granted to Claude Wilson, of Olive Hill, Ky.

GARDINER, ME.—The Kennebec Light and Heat Company has given a mortgage to the Union Safe Deposit and Trust Company to secure a loan of $400,000.

WHEELING, W. VA.—The capital stock of the Clarksburg Light and Heat Company has been decreased from $200,000 to $100,000 by vote of the stockholders.

COTTONWOOD FALLS, KAN.—The Smith Light and Power Company, of Bolivar, Mo., has received a franchise and is installing a plant at Cottonwood Falls.

CHILTON, WIS.—The electric light plant, owned by Nicholas Bink, has been sold to the American Electric Light, Heat and Cold Storage Company for $20,000.

NEWARK, N. J.—The board of trustees of the village of South Orange has appointed a committee to consider the question of a municipal electric light plant.

CENTER, TEX.—The electric light plant at Center was destroyed by fire on June 19. The plant was owned by Fleshman & Harkrider. There was no insurance.

MAYFIELD, CAL.—The citizens of Mayfield have decided to raise $8,000 in order to install an electric light plant to be operated in connection with the municipal water plant.

YANKTON, S. D.—A twenty-year franchise for lighting the city has been granted to S. G. Donaldson and associates, who will take over the old electric light plant and improve it.

WINSTON-SALEM, N. C.—Joseph Jacobs has been appointed receiver for the Winston-Salem Gas and Lighting Company. E. B. Jones, of Winston-Salem, is president of the company.

BLOOMSBURG, PA.—The American Electric Light Company, of Bloomsburg, contemplates a number of improvements in its plant. Contracts to the amount of $16,000 have already been let.

HIGHTSTOWN, PA.—At a town election held on June 20 the proposition to bond the town for $30,000 to establish a municipal electric light plant was defeated by a vote of 225 to 155.

HELENA, MONT.—John L. Bright, new owner of the electric light plant at Livingston, will expend $100,000 in improving the plant. New machinery is to be installed and a new power-house erected.

TOLEDO, OHIO—The Toledo Heating and Lighting Company has decided to issue $20,000 more bonds for improvements and extensions. The bonds will be placed on market at par without any stock bonus.

ALLENTOWN, PA.—The Bangor Electric Light, Heat and Power Company, of Bangor, Pa., has given a mortgage for $75,000 to the Northampton Trust Company, of Easton, to cover an increase of capital stock.

EAST TEMPLETON, MASS.—A company is being formed to build an electric light plant. Those interested are Percival Blodgett, G. W. Bourn, J. A. Stanley, H. E. Lowell, H. J. Wright and H. H. Hammond.

SAN FRANCISCO, CAL.—The contract for street lighting has been awarded to the San Francisco Gas and Electric Company for a lump sum of $320,000. The company is to provide 1,200 arc lights and 5,550 gas lamps.

SAN DIEGO, CAL.—A franchise has been granted to R. C. Hubbard, to build a power plant at the entrance to False bay. The term of the franchise is twenty-five years. The amount to be expended is estimated at $50,000.

PITTSBURG, KAN.—A trust deed from the Home Heat, Light and Power Company to the Fidelity Trust Company, of Kansas City, has been given to secure a loan of $20,000, and covers the electric light plant and gas works.

MURPHYSBORO, ILL.—The Carbondale Water, Light and Power Company has been placed in the hands of a receiver upon the application of the American Trust and Saving Bank, of Chicago, to secure payments of bonds and interest.

HARTFORD, CT.—At the annual meeting of the Farmington River Power Company directors were elected as follows: Austin C. Dunham, James L. Howard, Atwood Collins, Henry Roberts, E. C. Terry, John S. Hunter, W. T. Bacon, H. C. Judd.

ANSONIA, CT.—The city has entered into a ten-year contract with the Derby Gas Company for street lighting. The price to be paid for arc lights is seventy-five dollars per year per lamp, and for incandescent lamps twenty-four dollars per year per lamp.

PITTSFIELD, MASS.—The Monument Mills Company, of Housatonic, will develop the water power at Glendale. A dam 200 feet long and twenty-five feet high will be built and about 1,000 horse-power will be developed. The expenditure contemplated is $100,000.

WILMINGTON, DEL.—A franchise has been granted to the Wilmington Light, Heat and Power Company. The company must pay to the city two per cent of its gross receipts after 1907, and must use the conduits of the Delmarvia Telephone Company wherever possible.

NEWBURGH, N. Y.—At an annual meeting of the Upper Hudson Electric Company the following directors were elected: L. F. Gillespie, J. M. Sheehan, Miss A. B. Hedges, F. W. Titus, Eugene Wolfe and T. M. Sheehan. The directors elected the following officers: L. F. Gillespie, president; F. W. Titus, vice-president; J. M. Sheehan, secretary; Miss A. B. Hedges, treasurer.

CRESTON, IOWA—An electric company has been formed with a capital of $50,000, and the following directors have been elected: J. C. Sullivan, John Hackett, C. S. Rice, M. C. Welch, J. W. Reynolds, Harry Tramp and Edward Aldrich. The directors elected the following officers: president, J. C. Sullivan; vice-president, C. S. Rice: secretary, Dr. J. W. Reynolds; treasurer, John Hackett.

PENTWATER, MICH.—The Pere Marquette Light and Power Company has been formed to succeed the Oceana Electric Light and Power Company. The new company has a capital of $150,000. The officers are J. N. Cotton, president; George S. Root, vice-president; J. B. McCullen, treasurer. The company already owns land on Ruby creek, a site for water power, and the work of installing a dam will begin soon.

ANDERSON, S. C.—At the annual meeting of the Anderson Water, Light and Power Company the following board of directors was elected: S. M. Orr, J. A. Brock, R. E. Ligon, J. H. Anderson, J. M. Sullivan, H. H. Orr, all of Anderson; R. H. Wylie and W. Gill Wylie, of New York; A. T. Smyth and E. P. Frost, of Charleston. S. M. Orr was reelected president and treasurer; J. R. Vandiver, vice-president, and E. K. Chapman, secretary. The report of the officers showed that the company is in good condition.

PERSONAL MENTION.

MR. R. ARMSTRONG, of Morrisonville, Ill., has been appointed manager of the Taylorville Home Telephone and Telegraph Company.

MR. J. E. FARNSWORTH has been elected vice-president of the Southwestern (Bell) Telephone Company. Mr. Farnworth was formerly general manager.

MR. JOHN B. BLACK has been elected president of the Chester (Pa.) Electric Light and Power Company, to fill the vacancy caused by the death of his father, Mr. Harry B. Black.

MR. WILLIAM E. DICKINSON, New York city, has been elected assistant in the department of mechanical engineering at the University of West Virginia, Morgantown, W. Va.

MR. JOHN C. NICHOLSON, president of the Gas and Electric Company, of Newton, Kan., was a New York visitor this week. This company began operations in 1888, and has been successfully managed from the beginning.

MR. GEORGE SEAMAN has been elected general manager of the Fremont Home Telephone Company, of Fremont, Ohio. Mr. Seaman was formerly a collector of the company, and succeeds Mr. Robert Larkins, deceased.

MR. HARRY V. CROLL, M. E., for the past eight years with the E. P. Allis Company, and its successor, the Allis-Chalmers Company, at Chicago, has resigned to accept a position with the Wellman-Seaver-Morgan Company, Cleveland, Ohio.

MR. R. S. WILLIAMS, of Reidsville, N. C., has been appointed manager of the Burlington branch of the Southern Bell Telephone Company. He succeeds Mr. R. L. Lloyd, who has been transferred to the management of the Raleigh office.

MR. S. J. BAER, of Topeka, Kan., has resigned his position as western representative of the American Telephone Company to assume the position of assistant general manager of the Bell Telephone Company, with headquarters in Kansas City.

MR. W. W. FREEMAN has been elected vice-president and general manager of the Kings County Electric Light and Power Company and of the Edison Electric Illuminating Company, of Brooklyn, N. Y., in Manhattan. He succeeds the late Mr. E. A. Leslie.

MR. J. M. KINGELSMITH has resigned as treasurer and director of the Westerly (R. I.) Railway and Lighting Company, and also as president and director of the Mystic Electric and Gas Light Company, and as treasurer and director of the Westerly Gas and Electric Light Company.

MISS BESSIE R. BOUSLOG, daughter of Mr. Rawley Holland Bouslog, and Mr. Bryson Dexter Horton were married at the home of Mr. Bouslog in Peru, Ind., on Wednesday, June 28. Mr. Bouslog is the manager of the Peru Electric Manufacturing Company, and Mr. Horton a manufacturer of electrical supplies in Detroit.

MR. W. A. STADELMAN, eastern agent of the Wellman-Seaver-Morgan Company, who has been in charge of the eastern office at 42 Broadway, New York city, has been appointed general sales agent of the company with headquarters at Cleveland, Ohio, taking effect July 1. Mr. Fred Stadelman has been appointed assistant manager of the New York offices of the Wellman-Seaver-Morgan Company.

MR. DE LANCEY RANKINE has been appointed third vice-president of the Niagara Falls Power Company. Mr. Rankine is secretary and treasurer of the Cataract Power Company, of Buffalo, and secretary and treasurer and general manager of the Tonawanda Power Company and the Suburban Power Company. The new appointment involves his appointment as third vice-president of the Niagara Junction Railway, the Niagara Development Company, and the Canadian Power Company.

MR. HAROLD U. WALLACE, son of John F. Wallace, who recently resigned the chief engineership of the Panama Canal Commission, has accepted the third vice-presidency of J. G. White & Company, New York. Mr. H. U. Wallace resigns as chief engineer of the Illinois Central Railroad to accept this position. He has been connected with that road since 1894, and since 1902 as its chief engineer. Among other important work carried out by Mr. Wallace was the lake front improvement work at Chicago. This work included the depression and reconstruction of twenty miles of main lines and yard tracks. J. G. White & Company have recently secured the services of several eminent engineers, making many of the selections from the steam railroad field. In securing the services of this distinguished engineer they are carrying out this policy.

ELECTRICAL SECURITIES.

The fresh impulse which was given to the stock market a week ago continued to exert a favorable influence on speculation and activity during the past week. There were notable advances in many lines, and apparently there is more behind the active buying than a mere speculative fever. Despite the fact that with the increased activity early in the week prices made substantial advances, the commission house business continued good until the end of the week. At the close of the last session the market appeared to be in firm hands, and except for some apprehension with regard to the cotton report, the feeling was prevalent that with continued reports of good earnings from the railroads—some of which will probably report increased dividends for the year—there would be a maintenance of the present satisfactory conditions.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JULY 1.

New York:	*Closing.*
Brooklyn Rapid Transit	71⅝
Consolidated Gas	190¾
General Electric	176
Interborough Rapid Transit	200½
Kings County Electric	200
Manhattan Elevated	164½
Metropolitan Street Railway	127¾
New York & New Jersey Telephone	165
Westinghouse Manufacturing Company	180

New York & New Jersey Telephone directors have declared the regular quarterly dividend of 1½ per cent, payable July 15.

The net earnings of the Brooklyn Rapid Transit Company for the fiscal year ending June 30 are estimated at $6,642,000, an increase of $663,730.

At a meeting of the directors of the Kings County Electric Light and Power Company and of the Edison Electric Illuminating Company, of Brooklyn, a recommendation to the stockholders of the latter company that the authorized capital stock of the company be increased from $5,000,000 to $10,000,000 was adopted. A special meeting of the stockholders for the purpose of authorizing the increase has been called for July 10.

Boston:	*Closing.*
American Telephone and Telegraph	139¾
Edison Electric Illuminating	240
Massachusetts Electric	62
New England Telephone	136
Western Telephone and Telegraph preferred	101
Philadelphia:	*Closing.*
Electric Company of America	11¾
Electric Storage Battery common	76
Electric Storage Battery preferred	76
Philadelphia Electric	8¼
Philadelphia Rapid Transit	28⅛
United Gas Improvement	93
Chicago:	*Closing.*
Chicago Telephone	134
Chicago Edison Light	155
Metropolitan Elevated preferred	65
National Carbon common	65
National Carbon preferred	117
Union Traction common	6
Union Traction preferred	32

Metropolitan Elevated for June showed passengers carried to the number of 124,579, an increase of 7,325.

South Side Elevated for June showed a daily average of 93,941 passengers, an increase of 12,539, or 15 per cent, due to the White City amusement park.

Northwestern Elevated for June carried 75,837 passengers, an increase of 7,615. The total number carried for the fiscal year ended June 30 was 26,812,825, a daily average of 73,460. The gross passenger receipts were $1,340,641.

NEW INCORPORATIONS.

INDIANAPOLIS, IND.—Farmers' Mutual Telephone Company, of Patriot. $2,500.

NEWARK, N. J.—Morris County Traction Company. Increased from $250,000 to $2,750,000.

COLUMBUS, OHIO—Mount Sterling Telephone Company. Increased from $15,000 to $50,000.

JERSEY CITY, N. J.—The Southern Power Company. $7,500,000. Incorporators: R. B. Arrington, E. B. Sperry and W. R. Journeay, Jersey City.

CAIRO, N. Y.—Cairo Electric Light and Power Company, Cairo. $80,000. Directors: C. E. Hewitt, M. G. Hubbard, Chatham, N. J.; F. G. Walters, Cairo.

DOVER, DEL.—The Trolley Electric Vehicle Company of America. To carry on the business of common carriers of persons, freights and express. $1,000,000.

SPRINGFIELD, ILL.—The Consumers' Light and Heat Company, of Bloomington. $100,000. Incorporators: George M. Mattis, S. A. Power and Charles Zilly.

ST. PAUL, MINN.—The South St. Paul Electric Light, Heat and Power Company. $50,000. Incorporators: John Coates, Michael O'Toole, Emil Gardie, E. W. Erick and A. G. Baumgarten.

COLUMBUS, OHIO—Cleveland, Ashland & Mansfield Traction Company, with headquarters at Mansfield. $1,000. Incorporators: W. H. Abbott, A. J. Halle, C. W. Collister, Frank Butler and H. B. Cavanaugh.

AUBURN, N. Y.—The Woodworth Telephone and Telegraph Company, of Union Springs. $15,000. Directors: Henrietta Woodworth, O. J. Spencer, A. M. Seekell, Charles M. Hart, Michael McGrath, Laverne Dorimus.

ST. PAUL, MINN.—Winona Gas, Light and Coke Company, Winona. $300,000. Incorporators: H. S. Bolcom, L. L. Brown, Charles P. Cratigle, C. M. Morse, S. L. Prentiss, W. H. Stanchfield and R. E. Tearse.

COLUMBUS, OHIO—The Merchants' Heat, Light and Power Company, of Canton. $500,000. Incorporators: Thomas T. Turner, W. L. Stolzenbach, W. S. Shertzer, John Rommel, Charles T. Austin and B. T. Steiner.

SOUTH McALESTER, I. T.—The Coalgate Electric Light and Water Power Company, of Coalgate. $100,000. Incorporators: J. H. Carson, A. W. Archer, J. Bogg, Thomas Pope, E. McLaughlin, J. S. Hume and Mike Mayer.

HAMMONTON, N. J.—The Hammonton Telephone and Telegraph Company. $125,000. Directors: Andrew J. Rider, Richard J. Byrnes, William L. Black, Marcellus L. Jackson, Harry McD. Little, George Elvins, Edward H. White, L. Frank Horne, Benjamin W. Richards, Samuel Anderson, William J. Smith and William Colwell.

ALBANY, N. Y.—The Erie & Jersey Railroad Company. To construct a steam or electric railroad, forty-two miles long, from Highland Mills to Guymard, Orange County, to connect with the Erie Railroad at both points. $600,000. Directors: F. W. Underwood, president of the Erie; G. F. Brownell, F. L. Stetson and Charles Steele, of New York city.

ALBANY, N. Y.—The Oneida County Rural Telephone Company. To operate in Oneida County, with central exchanges in Stittville and Holland Patent. $7,500. Directors: Ellis D. Jones and J. Brayton Fuller, of Stittville; Ira G. Wells, John E. Jones and E. Willard Jones, of Holland Patent; Griffith D. Thomas, of Floyd, and Elias Lewis, of Steuben.

OTTAWA, QUEBEC—Kakaheka Power Company, Limited. $2,000,000. Incorporators: Herbert S. Holt, president of the Montreal Light, Heat and Power Company; Charles R. Hosmer, director of the Canadian Pacific Railway Company; Frederick W. Thomson, general manager and vice-president of the Ogilvie Flour Mills Company, Limited; Harold W. Norton, all of the city of Montreal, and Frank Hedley Phippen, of Winnipeg.

TELEPHONE AND TELEGRAPH.

FARGO, N. D.—A telephone system is to be established at Linton.

COALVILLE, UTAH—A franchise has been granted to the Independent Telephone Company.

COMPTON, CAL.—The Compton Home Telephone Company has completed a new line to Gardena.

NORWICH, N. Y.—The Sherburne Telephone Company is installing a new switchboard in its central office.

SALT LAKE CITY, UTAH—The Independent Telephone Company is erecting its pole line through American Fork.

BOLIVAR, N. Y.—The Bolivar Telephone Company has purchased the Oswego Valley Telephone Company's plant.

CHAGRIN FALLS, OHIO—The local telephone company has sold out to the Cuyahoga Telephone Company, of Cleveland.

SCHENECTADY, N. Y.—The Home Telephone Company is about to extend its lines from Schenectady to Rexford Flats

LEWISTOWN, MONT.—The ordinance granting a franchise to the Billings-Lewiston Mutual Telephone Company has been passed.

FARGO, N. D.—A telephone line is to be run across the country from Dickinson to Williston. It will touch the new county seat of McKenzie.

REDDING, CAL.—The Home Telegraph and Telephone Company, of San Francisco, it is announced, will construct a line from San Francisco to Portland.

HUMBOLDT, NEB.—Steps are being taken by the City Mutual Telephone Company to practically rebuild its system, putting in a new switchboard, cables, poles, lines, etc.

BREMERTON, WASH.—Steps looking toward the extension of the telephone system to include the towns of Tracyton, Silverdale and terminating at Browns Bay, are being contemplated.

DETROIT, MICH.—The Michigan Telephone Company has received a cable, weighing 13,865 pounds, at Trenton. This cable contains 102 wires and will be used in talking from the mainland to Grosse Isle.

SCOTTSBURG, VA.—The Scottsburg-Houston Telephone Company has been organized with J. T. Lacy, president, and R. A. Walden, secretary. The full amount of stock is taken and work will begin at once.

SCHENECTADY, N. Y.—Ten thousand feet of new telephone cable are being placed in conduits by the Home Telephone Company, and when the work is completed 300 new party lines will come into the switchboard at the central office.

WILKESBARRE, PA.—Extensive improvements are being made by the Bell Telephone Company between Wilkesbarre and Reading which will better the service to New York. Six new lines are being constructed to Monterey, near Reading.

MEDINA, TENN.—The Horn Telephone Company is proposing to build a line from Jackson to Medina, a distance of fourteen miles, and to establish an exchange at Medina. The Cumberland company has an exchange at Medina with about seventy subscribers.

LAWRENCE, MASS.—The New England Telephone and Telegraph Company has abolished its six-party line office telephone which had been leased for twenty-five dollars a year on a limited service, and substituted a one and two-party line limited service.

CAMERON, W. VA.—The Cameron Telephone Company is working on an extension of its lines from Loudenville to Glen Easton, and may build through to Moundsville, connecting with the National, giving a direct line to Wheeling, instead of by way of Littleton as at present.

COUPEVILLE, WASH.—After being down a year the Island Telephone Company's line is now in running order over twenty-five miles of territory. It has been partially repaired and connects Langley, Newell and Austin with the Sunset Telegraph and Telephone Company.

OWINGSVILLE, KY.—The Booneville & Burning Spring Long-Distance Telephone Company has been granted franchises by the

Lee County fiscal court to erect and maintain telephone lines in Beattyville and to extend its lines over the roads of Lee County. Work has already begun.

DOVER DEL.—A certificate of consolidation of the telephone companies in Virginia, two in Maryland and one in Delaware, under the name of the Diamond State Telephone Company, has been filed with the secretary of state. The certificate in no way affects the previous capital stock nor officers of the former Diamond State Telephone Company.

AINSWORTH, NEB.—At the annual meeting of the stockholders of the Keya Paha & Brown County Telephone Company the following officers were elected: president, Charles Hinneman; vice-president, Frank Sellers; secretary, F. A. Baldwin; treasurer, R. E. Jones. F. T. Brewster, William Slonecker and W. H. Williams were chosen as directors.

BUFFALO, N. Y.—The Consolidated Telephone Company, which recently acquired the stock of the Frontier Telephone Company, has increased its directorate. These men have been elected: John Markle, Wilkesbarre; J. Sloat Fassett, Elmira; E. Frank Brewster, Rochester; George W. Thayer, Rochester; V. Moreau Smith, Rochester; Charles W. Goodyear, Buffalo.

CHERRY CREEK, N. Y.—The annual stockholders' meeting of the Conewango Valley Home Telephone Company was held in the village of Cherry Creek, June 13. The members of the old board were reelected with two exceptions, E. W. Curtis, of Cherry Creek, being elected in the place of C. H. Lake, resigned, and Hugh Taylor, of Buffalo, in the place of B. G. Hubbell.

HAMILTON, OHIO—The Central Union Telephone Company has commenced the construction of seventeen new circuits throughout Butler County. The completion of these circuits will establish direct telephone service with Astoria, Poasttown, Blue Ball, Monroe, Miltonville, Trenton, Overpeck, LeSourdsville, Jacksonboro, Carlisle and with resident farmers along the lines.

GREENE, N. Y.—At a meeting of the Broome-Chenango Telephone Company the following directors were elected: J. D. Van Valkenburgh, Frank Cooper, A. M. West, Mason Hallenbeck, George W. Webb, R. P. Bunnell and W. H. Powers. The following officers were then elected: president, J. D. Van Valkenburgh; vice-president, Mason Hallenbeck; secretary and treasurer, George W. Webb.

ALBANY, IND.—The Eureka Telephone Company, of Harrison County, has elected E. F. Windell, president; L. Cunningham, vice-president; H. C. Beanblossom, secretary; H. C. Hays, treasurer; Morris Fleichman, superintendent. Over 300 of the 700 stockholders attended the meeting. The company is made up almost entirely of farmers, and nearly all the stockholders are patrons of the service.

ALBUQUERQUE, N. M.—General Superintendent E. M. Burgess, of the Colorado Telephone Company, announces that the company will make improvements in the local system to cost $60,000. The company will erect a three-story exchange building, rebuild its line, and install the latest pattern of telephones throughout the city. The Colorado Telephone Company was granted a forty-year franchise by the city council recently.

ALBANY, N. Y.—The New York & Rockaway Telegraph and Messenger Company has been incorporated with the secretary of state, to operate lines beginning in Brooklyn and extending to Rockaway and Far Rockaway, and connecting with intermediate places. The capital stock is $5,000, and the directors are Simon E. Ostram, C. F. Young, Theodore Miller and Edward J. Canty, of Brooklyn, and D. D. Dillon, Glen C. Heath and W. L. Kearney, of New York city.

PARK CITY, UTAH—At a regular meeting of the city council the franchise of the Utah Independent Telephone Company was granted by a vote of three to two. The franchise gives the company the right to operate for a period of fifty years, and gives the city the right to purchase the exchange at any time the council desires. It also provides for underground wires on Main street; for a fifteen-cent toll rate between Salt Lake and Park City, and a twenty-five-cent rate between Ogden and Park City.

PORT ANGELES, WASH.—Port Angeles is to have long-distance telephone connections with the cities of Puget sound within the next sixty days. Contracts have been signed between the Port Angeles Telephone and Telegraph Company, and the Independent Telephone Company. The Independent Company already has lines into the east end of Clallam County, connecting the towns of Dungeness, Sequim, Blyn and Port Williams with Port Townsend and the upper sound cities which lines are to be improved.

CINCINNATI, OHIO—The Cincinnati & Suburban Bell Telephone Company has purchased the plant of the Independence (Ky.) Telephone Company, and it will hereafter be run in conjunction with the local company. The Independence Company had about 150 subscribers, and over fifty additional have been added. The exchange at Independence will be operated as a branch of the local exchange. This is the first of a large number of smaller telephone companies which the local company is planning to take over.

FREEHOLD, N. J.—George H. Atkinson, as trustee, sold recently at public vendue all the rights, title and interest in the Red Bank Telephone Company, and the Freehold Telephone and Telegraph Company. Both of these companies were local stock companies, and have not been in operation for more than a year. The Red Bank plant was purchased by Henry C. McLean, of Red Bank, for $2,550. This company was organized with a capitalization of $15,000. The Freehold Telephone and Telegraph plant was purchased by George W. Eggert, of Perth Amboy, for $1,550. This company was organized with a capitalization of $10,000. Both the plants, the purchasers assert, will be put in first-class condition and subscribers solicited.

ONAWA, IOWA—The Monona County Telephone Company has been absorbed by the new State Telegraph Company, of Sioux City, which also takes over the local exchange at Onawa and other towns in the county. Onawa now has about 300 telephones. The Monona Telephone Company received $60,000 in stock in the new company for its interest in the county. The full list of new towns involved in the deal is as follows: Onawa, Blencoe, Turin, Castana, Soldier, Moorhead, Whiting, Maple Landing, Lossing, Albaton, Sloan, Rodney, Grant Center, Ticonie, Salix and Sergeant Bluffs. This makes the new State Company the owner of all independent lines within fifty miles of Sioux City. The company is now at work on its copper line to LeMars, and proposes to extend its system in all directions.

ST. JOHN, NEW BRUNSWICK—At the annual meeting of the New Brunswick Telephone Company it was decided to erect a number of lines during the present season. These will include a line from Chatham to Dalhousie, connecting with Bathurst, Campbellton and other places along the North shore, also a line from Canterbury to McAdam, another from St. Stephen to Moore's Mills and from Lepreaux to Musquash; also to connect with the Kamaraska Telephone Company, by extending the line to Edmundston; to erect a $6,000 brick building on Carleton street, Fredericton, for the use of the company's head offices, and to improve the Moncton and Fredericton plants. The directors were reelected as follows: the Hon. A. G. Blair, J. L. Black, Charles Fawcett, Dr. Stockton, M. P.; the Hon. F. P. Thompson, W. T. Whitehead, M. P., Fredericton, and C. F. Size, Montreal. At a subsequent meeting of the directors the Hon. A. G. Blair was reelected president; J. L. Black, vice-president; the Hon. F. P. Thompson, treasurer; W. E. Smith, secretary.

NEW HAVEN, CT.—The Southern New England Telephone Company's promised reduction in telephone rates, which it has submitted to the judiciary committee of the legislature, has been made public, and shows many quite sweeping reductions all over the state. The cut in New Haven, Hartford and Bridgeport will take effect January 1, 1906. The $100 business service will be given for $84; $72 for $60, and the $36 residence service for $30. The measured service rates (limited number of calls) are also reduced somewhat. In Waterbury the $100 service will be given for $72; $72 for $55; $48 for $40; $36 for $30. Measured service reduced. Effective July 1, 1905. In Danbury, Meriden, Middletown, New Britain, New London, Norwich, South Norwalk and Stamford, effective October 1, $72 service for $60; $48 for $42; $42 for $36; $30 for $24. Measured service reduced. A "farmers' service" is offered by the company, by which arrangement any group of farmers' lines one mile from the central office will be met by the Southern New England people, who will connect the farmers with the New England service at $9 per year. This applies to farmers who have their telephones. The subscribers to this system will have to own their own lines and take care of them.

INDUSTRIAL ITEMS.

THE DE LA VERGNE MACHINE COMPANY, New York city, is distributing a handsome booklet describing the Koerting two-cycle gas engine.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., has issued a booklet describing its exhibits at the Lewis and Clark Exposition, at Portland, Ore.

THE WHEEL TRUING BRAKE SHOE COMPANY, Detroit, Mich., is calling attention to the brake shoe made by it, by means of an attractive mailing card. This shoe is designed to true up flat or untrue wheels without removing the car or engine they are on from service.

THE ASHCROFT MANUFACTURING COMPANY, 85-89 Liberty street, New York, has issued a catalogue descriptive of the Tabor steam engine indicator, and auxiliary appliances for the same. Both inside and outside spring indicators are shown, and also various reducing motions.

A. L. IDE & SONS, Springfield, Ill., have issued a booklet describing the Ideal engine. The book shows the relation of the engine to economical operation of the power plant, and describes the various features of the Ideal engine quite fully. All the novel points of the engine are illustrated by half-tone engravings.

THE WILLARD STORAGE BATTERY COMPANY, Cleveland, Ohio, whose factory was burned on June 26, has secured a new location and will be in shape to commence deliveries of material in about a week. The company expects to have its factory going in good shape in thirty days. The new location is at 29-31 Academy street.

THE AITON MACHINE COMPANY has just issued its bulletin No. 7, showing a seven-wire stranding machine; also bulletin No. 18, showing cable reel winding gear, and would be pleased to furnish any one who would be interested in this type of machinery with copies of bulletins which it has on file at its offices, 126 Liberty street, New York city.

THE NATIONAL BATTERY COMPANY, Buffalo, N. Y., is calling attention to its line of storage batteries. These are made for many different services, including street railway, power and lighting plants, vehicles, motors, fire-alarm and telephone and telegraph. The company publishes a descriptive catalogue which it will be pleased to send on application.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., is having built by the Bethlehem Steel Company three crank-shafts, which will weigh 86,600 pounds each when finished. They are turned out of solid steel ingots, twenty-five by four by four feet, and are intended for three Snow gas engines, which are to drive 4,000-kilowatt Crocker-Wheeler alternators, the largest gas-engine-driven generators ever built. These machines were ordered by the California Gas and Electric Corporation.

FRANK B. COOK, Chicago, Ill., announces three additions to the sales department, as follows: M. A. Gurney, covering Michigan, Indiana and Iowa; C. C. Newburn, Minnesota and the Dakotas; F. A. Rader, Kansas, Nebraska and the Territories. New York and Pennsylvania are being covered by James Strasburg; Wisconsin and Illinois by G. C. Fricke, and Iowa and Missouri by F. R. Parker. These gentlemen will push the sale of Cook's self-soldering protectors, pole cable terminals, and construction material.

THE CHICAGO & ALTON RAILWAY has, for the greater convenience of its patrons, installed at a number of its stations an automatic electric device known as the train bulletin. The bulletin is, in appearance, like a large clock, and indicates upon the dial whether a train is on time, or if not the number of hours or minutes late. These bulletins are placed in station waiting-rooms and in the principal hotels and are controlled by the operator at the depot. All bulletins, in the waiting-rooms and in the hotels, register precisely similar at one and the same instant. The operator indicates on the bulletin the number of the train next due to arrive and the time of its arrival.

THE STAR ASBESTOS MANUFACTURING COMPANY, 56 Fulton street, New York city, exhibited at the Railway Men's convention, at Manhattan Beach, its triple-combination cable wrapping. This is an improved method for wrapping lead-covered transmission cables to protect them from injury, either mechanical or through general burnouts. It is now generally appreciated by electrical interests throughout the entire country that it is necessary to apply some method of cable protection. In addition to the triple combination, this company is introducing asbestos braided tubing for the covering of light electrical wires, and it is prepared to manufacture any form of asbestos textile products which may be desired.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., reports having closed a contract with the Kinlock Telephone Company, St. Louis, Mo., for a new central-energy, lamp-line, multiple switchboard of 17,000 lines capacity for its main exchange. The contract calls for an "A" board consisting of thirty-seven sections, a "B" board consisting of ten sections, three monitor sections of two operators' positions each, one observation desk of four positions, one combination manager and assistant manager's desk, one combination chief and assistant chief operators' desk, one two-position wire chief's desk. The main switchboard is to be equipped for the present with 12,500 lines, thus making it the largest original installation ever made in the independent field.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., has closed a contract for the equipment of the main generating station and four rotary converter substations of the Cincinnati Northern Traction Company. The power-house will be located at Hamilton, Ohio, and the original installation will be of 5,000 kilowatts capacity, with provision for ultimately increasing it to 10,000 kilowatts. The generating station will contain three 1,500-kilowatt and one 500-kilowatt, three-phase, rotating-field, enclosed, turbo-type generators, and three 300-kilowatt rotary converters. Current will be generated at 375 volts. The outgoing lines will be equipped with raising transformers with a ratio of 375 to 33,000 volts. The generators will be driven by Westinghouse-Parsons steam turbines, and excited by a direct-current generator attached to the end of the turbine-shaft. Each substation will contain a 300-kilowatt rotary converter supplied by three-kilowatt, 33-375-volt step-down transformers of the oil-insulated, self-cooling type. The contract includes all necessary switchboards and protective devices.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., had on exhibition a fine lot of apparatus at the convention of the Street Railway Association of the State of New York, Lake George, June 27 and 28. The company's exhibit occupied one-half of the northern end of the exhibit hall. The latest design of forty-horse-power railway motor, known as the GE-80, was shown, with various renewal parts for this and other railway motors. An interesting feature was the air-compressor automatic governor which was shown in section. There was also a complete assortment of line material, including catenary suspension devices for alternating-current trolley installation. In addition to this were controller contact fingers, fuse blocks, and a series of moving pictures of electric railway subjects. These pictures included a Ballston-Schenectady alternating-current trolley car in operation, the Interborough Rapid Transit cars in New York city, and the New York Central electric locomotive racing with a steam locomotive. The company was represented by T. Beran, manager, New York office; H. G. Grier, New York; J. C. Calisch, Buffalo; H. H. Crowell, Syracuse; W. Gibson Carey, Schenectady; E. M. Kinney, Schenectady, and F. H. Gale, advertising manager, New York.

NEW MANUFACTURING COMPANIES.

LOUISVILLE, KY.—The Cooper-Hewett Company has been incorporated with a capital of $10,000, to deal in steam and electrical supplies. The incorporators are A. R. Cooper, Leon H. Cooper, H. B. Hewett and L. A. Hewett.

BALTIMORE, MD.—The Electric Manufacturing Company, to deal in electrical supplies, etc., has been incorporated with a capital stock of $2,000, by James L. Murrill, Edward V. Quigley, Charles H. Miles, William G. Thumm and William E. Hoffman.

ST. PAUL, MINN.—The Columbia Improvement Company, of Portland, Me., manufacturer of electrical motors and dynamos, has been authorized to do business in Minnesota by the secretary of state. The capital stock is $100,000. Jeremiah Smith, Jr., of Boston, is president of the company.